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VOLUME XXVII (1941)

CONTAINING PAPERS SUBMITTED AT THE ANNUAL MEETING IN 1941

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PART I BOTANY AND FORESTRY

PART II ZOOLOGY

PART III GEOGRAPHY AND GEOLOGY

PART IV GENERAL SECTION

ANTHROPOLOGY, HISTORY AND POLITICAL SCIENCE, LANGUAGE AND LITERATURE, MEDICAL SCIENCE, SOCIOLOGY

PAPERS OF THE MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

EDITORS

EUGENE S McCARTNEY

WILLIAM C STEERE

VOLUME XXVII (1941)

"Pusilla res mundus est nisi in illo
quod quaerat omnis mundus habeat"
— SENECA, *Naturales Quaestiones*

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BOTANY

INHERITANCE OF TWO FACTORS AFFECTING ANTHOCYANIN DISTRIBUTION IN FLOWERS OF PETUNIA *

ERNEST E DALE

IN THE course of inheritance studies in the garden petunia, *Petunia hybrida*, two factors have been isolated which affect the distribution of anthocyanin in the flowers The first (Figs 1–2) tends to inhibit the production of anthocyanin in the veins of the part of the corolla immediately adjacent to the throat margin The second (Fig 3) largely inhibits anthocyanin development in the outer limb of the corolla The first type will be designated "pale-veined", the second, "pale corolla "

TABLE I

SEGREGATION FOR PALE-VEINED FLOWERS IN PETUNIA

F_1 GENERATION

Family	Dark-veined	Pale-veined	Expected numbers	Standard error
1594	7	3		
1674	78	23		
1693	37	13		
Total	122	39	121 40	5 4

Backcross

1734 *	49	50	49 50	5 0

* The reciprocal backcross failed to produce viable seed

PALE-VEINED

The pale-veined type first appeared in a pink-flowered variegated strain of petunia which has been called "stippled" (unpublished)

* Papers from the Department of Botany and Botanical Gardens of the University of Michigan, No 796

Stippled flowers have a fine-speckled appearance, but this is hardly brought out in the photographs (Figs 1–2) The character is unstable, and stippled plants often bear some normal flowers In an inbred culture of ten pink-stippled plants three bore flowers in which the veins about the throat margin were *pale* (Fig 1), the remaining seven bore dark-veined flowers (Fig 2) To test the genetic constancy of *pale-veined* a progeny of eighty-two plants was grown from seed of selfed flowers All were *pale-veined* It seemed probable that *pale-veined* was a recessive monogenic character, and the data of Table I fully bear out this assumption

TABLE II

SEGREGATION FOR NORMAL AND PALE COROLLA IN PETUNIA

F_2 GENERATION

Family	Normal	Pale corolla	Expected numbers	Standard error
1605	71 *	20		
1608	7	1		
Total	78	21	74 25	4 1
		Backcross		
1622	53	43		
1632	51	49		
Total	104	92	98 98	7 0

* Includes four light-colored plants

PALE COROLLA

Malinowski (1914) and Rasmuson (1918) have described crosses involving a factor which appears to be genetically the same as the pale-corolla type reported here Discussion of their work, however, will be deferred to a later part of the paper

Newly opened flowers of the pale-corolla strain are a light purplish violet ("bishop's purple", Ridgway) By the time the anthers dehisce the flowers normally become paler, being approximately "pale Hortense violet" (Ridgway), and eventually they may fade to nearly white But fading is markedly affected by environmental factors, since plants grown in the greenhouse and blooming before the first of May showed only a slight change in flower color.

The inheritance of *pale-corolla* was studied in crosses with normal purple. Thirty-nine F_1 plants were obtained, and all were *normal*. The F_2 and the backcross data are given in Table II.

Four F_2 plants which bore light-colored flowers intermediate between typical *normal* and *pale corolla* have been classified as normal. It is known that F_1 hybrids of *pale corolla* × *white* and *pale corolla* × *pink* are purple. *Pale corolla,* therefore, carried the factor for purple. Since dark color (purple) is strongly inhibited in the presence of *pale corolla,* it seems likely that the light-colored plants referred to were not genetically *pale corolla*. But it is to be noted that, whether these plants are classed as *pale corolla* or *normal,* the data conform to expectation for recessive monogenic inheritance.

DISCUSSION

Malinowski (1914) obtained a ratio of 9 self-red : 3 red-veined : 4 self-white in F_2 of a cross between red-veined and a white-flowered variety of petunia. He assumed, in addition to a factor for color, a factor B "causing the distribution of color on the whole surface of the corolla, in the absence of the B factor ... the only colored parts of the flower are the veins." It seems probable that Malinowski's B factor corresponds to the pale-corolla factor discussed in the present paper, but that *pale corolla* produces more pigment.

The study by Rasmuson (1918), which appears to involve the pale-corolla factor, concerned a cross between a variety of petunia with near-white flowers and a purple-flowered type. In F_2 he obtained 282 dark-colored : 98 light-colored plants. He found a high degree of variability among his light-colored F_2 segregates, but lumped them together as one genetic type. If the present writer's interpretation of the intermediate light-colored F_2 plants in Table II is correct, Rasmuson's procedure presumably involves some error. As was to be expected, no such intermediate types occurred in the backcross (Table II).

Pale-veined, as already stated, was found associated with a pink variegated strain of petunia which has been called "stippled." Like many other variegations, stippled plants occasionally produce some normal flowers, and an examination of these reverted normal flowers on pale-veined plants showed that the veins were fully colored. In sixteen pale-veined plants which bore some normal flowers the reverted normal flowers were in all cases *dark-veined*. In addition to

bearing occasional normal flowers, stippled plants sometimes produce chimeras, which combine sectors of normal and stippled tissue in one flower Two such chimeral flowers were found, and in both the reverted normal sectors were *dark-veined*, whereas in the stippled areas the veins were pale Thus the pale-veined factor produces no visible effect in the normal flowers of the stippled strain, but inhibits the production of color in the veins about the throat margin of the flowers when associated with "stippled"

Since "stippled" is recessive to *normal* and *pale-veined* is recessive to *dark-veined*, it appears that *pale-veined* may be determined by two pairs of complementary recessive genes Critical tests of this hypothesis are being carried out

Union College
Schenectady, New York

LITERATURE CITED

Malinowski, E 1914 O dziedziczeniu niektórych cech u Petunii Compt rend des séances de la Société des sciences de Varsovie, 7 533–544

Rasmuson, H 1918 Über eine Petunia-Kreuzung Bot Notiser, 1918 287–294

FIG. 1, *pale-veined*

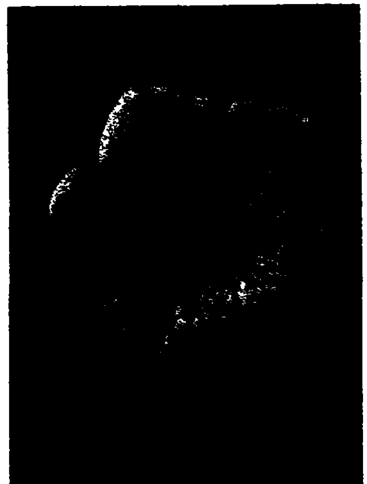


FIG. 2, *dark-veined*

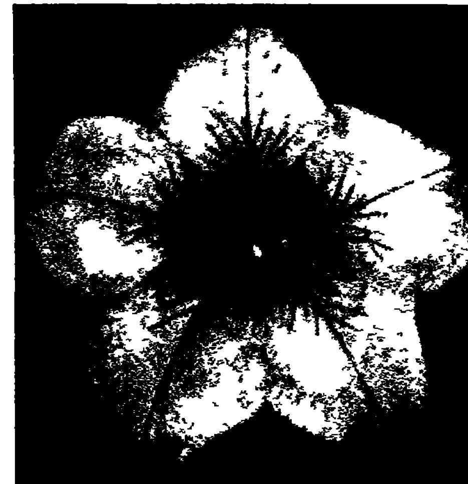


FIG. 3, *pale corolla*

Petunia flower types All × 1

NOTES ON CAULERPA FROM JAVA AND THE PHILIPPINES *

WILLIAM J GILBERT

IN THE course of graduate work at the University of Michigan the writer has had available for study the Chlorophyceae of several large algal collections from the region of Java and the Philippines The Javanese collection was made under the direction of Dr A J Kostermans, with the cooperation of the Laboratorium voor Onderzoek der Zee, Batavia, in the months of September and October, 1938 The material was preserved in formalin and sent to the University of Michigan in a score of five-gallon tins, where it was sorted and mounted and where collection numbers were assigned In all there are 18 collecting localities, chiefly islands in the Bay of Batavia and in the Thousand Islands to the north, a few scattered stations range westward and south to Oedjoengkoelon, the western cape of Java Two lots were gathered from the southern coast of Sumatra

During the year 1935 Professor H H Bartlett, chairman of the Department of Botany, University of Michigan, was acting as an exchange professor at the University of the Philippines, Manila While there he made a large collection of marine algae from all parts of the islands, which was given to the University of Michigan for identification and distribution This collection includes a few specimens contributed by various students working with him at that time

Furthermore, the New York Botanical Garden has loaned the writer its Philippine Chlorophyceae, most of which have never been reported upon and which consist largely of collections made in 1911 and 1913 by Dr E D Merrill, Dr W R Shaw, and others There are also miscellaneous specimens and a few which were gathered by naturalists of the United States Fish Commission attached to the S S *Albatross* on an expedition conducted during the years 1907–10

* Papers from the Department of Botany of the University of Michigan, No 782

So far as the writer is aware, the exact locality in the Philippines where the *Albatross* collections were made, and the month of year, are not known

Abundant in this material is the genus Caulerpa, comprising more than 120 collection numbers and including a total of twelve species, with numerous varieties and forms In his study the writer has been so impressed with the degree of variation of size and structure in certain of the species and with the number of transition forms from one species to another where there are many collections that he feels the line delimiting certain species of Caulerpa may be purely arbitrary The absence of practically all field data, and also of preserved material for all but the Javanese collection, has been a real handicap in the satisfactory analysis of the plants at hand, since field data is especially vital in dealing with a polymorphic genus such as Caulerpa

The marine flora of the region of the Netherland East Indies is already fairly well known through the monumental work for that area, Mme A Weber–van Bosse's *Liste des algues du Siboga* (1913–28)

The Philippine algal flora, on the other hand, is comparatively unknown Fewer than a dozen articles mention any Chlorophyceae, and these are all short lists, with the exception of the papers by Martens (1866) and Dickie (1876), which, though still lists, enumerate approximately seventy-five and fifty species respectively In addition, the work of Mme Weber–van Bosse mentioned above covers the Sulu Archipelago, where a considerable number of Professor Bartlett's Philippine collections were made

Ten of the twelve species reported in the present paper were found in the Javanese collection, but all ten have previously been listed from the Netherland East Indies, along with a considerable number of others (see Weber–van Bosse, 1913, pp 96–114) Ten species (including those from the Sulu Archipelago) are here recorded from the Philippines, four of them (*Caulerpa fastigiata, C parvifolia, C cupressoides*, and *C lentillifera*) newly listed for the islands This brings to eleven the total number of species of Caulerpa known from the Philippines, with *C selago* reported from the Sulu Archipelago but not found in the present material

Following are the species, varieties, and forms represented in the several collections Many call for no descriptive note, but in the more variable species some attention has been given to varietal and form differences

List of Species

CAULERPA Lamouroux, 1809

1 *Caulerpa fastigiata* Montagne

References — Montagne, 1838, p 19, pl 2, fig 3, Weber–van Bosse, 1898, p 262, pl 20, figs 1–2, 1913, p 96, Børgesen, 1913, p 118, fig 93, Okamura, 1916, 4 (1) 14, pl 154, figs 9–13, Taylor, 1928, p 98, pl 12, fig 12

Distribution — Widely distributed in tropical waters

Collections — Philippines *Villaflores 48*, Lubang Island, Mindoro Province, Sept Java *Kostermans 194*, Kaliage, Thousand Islands, Oct

2 *Caulerpa verticillata* J Agardh

References — Agardh, J , 1847, p 6, 1872, p 6, Weber–van Bosse, 1898, p 267, pl 20, figs 7–10, 1913, p 96, Svedelius, 1906, p 108, fig 1, Børgesen, 1907, p 355, fig 1, 1913, p 121, figs 95–96, Taylor, 1928, p 103, pl 12, fig 7, pl 13, fig 2, Yamada, 1934, p 62, figs 31–32, Tseng, 1936a, p 175

Distribution — Widely distributed in tropical waters

Collection — Java *Kostermans 610*, Anjer, west coast of Java, Oct

3 *Caulerpa brachypus* Harvey

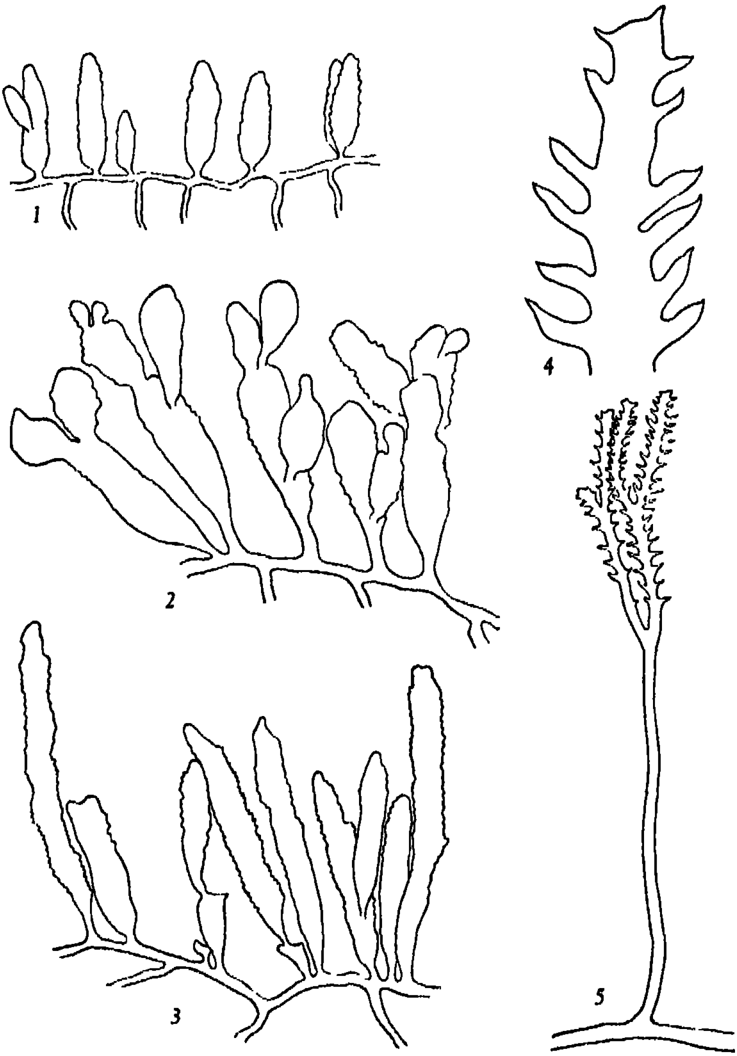
(Figures 1–3, p 10)

References — Harvey, 1859, p 333, Agardh, J , 1872, p 11, Kjellman, 1897, p 33, Weber–van Bosse, 1898, p 280, pl 22, fig 2, 1913, p 97, Yamada, 1934, p 65 *Caulerpa anceps* Harvey, Alg exc Fr Isl , n 67, Agardh, J , 1872, p 9, Weber–van Bosse, 1898, p 281, pl 22, figs 6–10, Yendo, 1903, p 153, Okamura, 1914, 3 (5) 94, pl 125, figs 1–8, Segawa, 1935, p 62 *C Stahlii* Weber–van Bosse, 1898, p 282, pl 22, figs 3–4

Distribution — Japan, Polynesia, Malay Archipelago

Collections. — Java *Kostermans 189*, Kaliage, Thousand Islands, Oct , *261*, Eil Kelapa, Thousand Islands, Oct , *321*, Poeloe Tjina, Thousand Islands, Oct

The three collections from the region of Java include specimens which show this to be an extremely variable species In the material at hand lie forms which could easily have fallen into *Caulerpa anceps*



Figs 1–3 *Caulerpa brachypus*, showing variation in form Figures 2–3 illustrate forms originally thought to be *C Stahlii* and *C anceps*, respectively All × 1

Figs 4–5 *Caulerpa serrulata* var *Boryana* f *longifolia*, f nov Fig 4, detail of upper part of one frond, × 10 Fig 5, habit, × 1 5

Harvey and *C Stahlii* Weber–van Bosse if Yendo (1903, p 153) had not shown them to be only growth forms of *C brachypus* Yendo suggests that the different forms are related to the season of the year in which the plant is found, but this is to be questioned, inasmuch as in the present collections, all of which were gathered within a period of two consecutive days, all the different forms are to be observed (Figs 1–3) Rather, either the age of the plant or its immediate habitat is the likely determining factor affecting its form Unfortunately, a description of the habitats in which the Javanese specimens were found is not available

In several ways *Caulerpa brachypus* resembles *C prolifera* Forsskål, and it is interesting to note that in the present material several of the fronds have margins which are entire except for a few small serrations, thus suggesting *C prolifera* even more On the same stolon, however, are fronds with delicate serrations around the entire edges, which, along with the fact that the fronds are also subsessile, indicates that the plant is not this species From the Indo-Pacific region *C prolifera* has been reported but once, by Weber-van Bosse (1913, p 97), from Tanah Djampeah Since at that time she called attention to the serrate character of a portion of the margin of one frond, it would seem that her specimen may well have been *C brachypus* The fact that Weber–van Bosse herself doubted the accuracy of her determination would tend to confirm the opinion that this report of *C prolifera* in the Indo-Pacific region is questionable and that the plant with which she dealt may have been, as even she proposed, a large form of *C brachypus* The fronds of *C prolifera* may have an undulate or, as generally, an entire margin, but are never spoken of as having teeth or as being serrate

4 *Caulerpa parvifolia* Harvey

References — Harvey, 1860, pl 172, Agardh, J , 1872, p 10, Weber-van Bosse, 1898, p 281, pl 22, fig 5, 1913, p 98, Okamura, 1930, p 105, 1931, 6 (6) 58, pl 280, fig 1, Yamada, 1934, p 66, fig 35, Tseng, 1936a, p 176, fig 29

Distribution — Japan, China Sea, Malay Archipelago, Australia

Collection — PHILIPPINES *Bartlett 14993*, Dalupiri Island, Babuyan Group, Nov

The largest frond is 11 mm long, the usual length is 3–6 mm , and the width, 2–3 mm

5 *Caulerpa crassifolia* (C Agardh) J Agardh

References — *Caulerpa taxifolia β crassifolia* C Agardh, 1822, p 436 *C crassifolia* (C Agardh) J Agardh, 1872, p 13, Svedelius, 1906, p 109, Vickers, 1908, pl 40, Weber-van Bosse, 1913, p 99, Børgesen, 1913, p 130, figs 102–103, 1939, p 74, Taylor, 1928, p 96 *C pinnata* (L) Weber-van Bosse, 1898, p 289

Distribution — Polynesia, Malay Archipelago, Indian Ocean, Red Sea, Canary Islands, Caribbean

Collection — Philippines *Albatross Expedition 34*

Only a small plant was collected, most of its ramuli are rounded at the tip rather than mucronate It is f *typica* (Weber-van Bosse) Børgesen (1913, p 131)

6 *Caulerpa taxifolia* (Vahl) C Agardh

References — *Fucus taxifolius* Vahl, 1802, p 36 *Caulerpa taxifolia* (Vahl) C Agardh, 1822, p 435, Harvey, 1860, pl 178, Weber-van Bosse, 1898, p 292, 1913, p 100, Svedelius, 1906, p 112, Børgesen, 1907, p 563, 1913, p 131, figs 104–105, 1932a, p 58, Vickers, 1908, pl 41, Okamura, 1913, 3 (2) 38, pl 110, figs 4–5, Yamada, 1934, p 67, Tseng, 1936a, p 180

Distribution — Japan, China Sea, Philippines, Polynesia, Malay Archipelago, Indian Ocean, Caribbean

Collections — Philippines *Bartlett 16128*, North Ubian Island, Sulu Archipelago, Sept Java *Kostermans 263a*, Eil Kelapa, Thousand Islands, Oct , *467c*, Poeloe Pajoeng, Oct , *611a*, Anjer, west coat of Java, Oct

7 *Caulerpa sertularioides* (Gmelin) Howe

References — *Fucus sertularioides* Gmelin, 1768, p 154, pl. 15, fig 4 *F plumaris* Forsskål, 1775, p 190 *Caulerpa plumaris* (Forsskål) C. Agardh, 1822, p 436, Kützing, 1849, p 496, Dickie, 1876, p 245, Weber-van Bosse, 1898, p 294, pl 24, figs 4–6, 10 *C sertularioides* (Gmelin) Howe, 1905, p 576, Svedelius, 1906, p 114, figs. 7–10, Børgesen, 1907, p 365, fig 11, 1913, p 133, fig 106, Vickers, 1908, pl 42, Collins, 1909, p 334, Weber-van Bosse, 1913, p 100, Okamura, 1913, 3 (2) · 36, pl 110, figs 1–3, Yamada, 1934, p 68, Tseng, 1936a, p 179

Distribution. — Widely distributed in tropical waters.

F *brevipes* (J Agardh) Svedelius

Reference — Svedelius, 1906, p 114

Collections — PHILIPPINES *Bartlett 14021*, Manila Channel, Puerto Galera, Mindoro, 1935 JAVA *Kostermans 51*, Eil Hoorn, Bay of Batavia, Sept

F *longiseta* (Bory) Svedelius [perperam *C sertularioides* f *longiseta* (J Agardh) Svedelius]

Reference — Svedelius, 1906, p 114

Collections — PHILIPPINES *Bartlett 13940*, Puerto Galera Bay, Puerto Galera, Mindoro, May, *15579*, small island opposite Culion Harbor, Culion Island, Calamian Group, July *Merrill 9144*, Taytay, Palawan, April *Shaw 1130*, Cabcaban, Bataan Province, Luzon, May JAVA *Kostermans 184*, Kaliage, Thousand Islands, Oct , *264*, Eil Kelapa, Thousand Islands, Oct , *324*, Poeloe Tjina, Thousand Islands, Oct , *467a* and ? *467b*, Poeloe Pajoeng, Oct , ? *586*, Poeloe Toenda (P Babi), Oct , *611b*, Anjer, west coast of Java, Oct

In the literature there is considerable confusion regarding the limits of f *longiseta*, but this seems unwarranted in view of the fact that the original description of *Caulerpe plumaire* var β *Longiseta* Bory (1826, pp 193–194, pl 22, fig 4) seems quite definite Bory used the term to apply to plants of this species that are soft and that have fronds which are nearly always simple and borne singly, which are sessile or very briefly pedicellate, and which are 2 0 3 5 inches high, with ramuli 0 45–0 78 or even 1 0 cm long

The plants from Java and the Philippines under this form seem to fall into two general groups, the aspect of which is much the same, but which differ in size of frond, length of ramuli, and closeness with which the ramuli are arranged The first group, including most of the Javanese plants, are of the smaller type, in which the ramuli are about 15 to a centimeter and 0 5–0 7 cm long, and in which the fronds reach a height of 4 0 cm and have a very soft appearance Svedelius (1906, p 114, figs 7–10) has illustrated this group

Bartlett 15579 and *Merrill 9144*, from the Philippines, represent the second group, in which the ramuli are 10–11 to a centimeter and up to 1 0 cm. long, and in which the fronds may reach a height of 9 0 cm. and in general appearance are coarser than those of the plants

mentioned previously Branching rarely occurs in either group *Shaw 1130*, from the Philippines, clearly represents a transition between these two general types, and it would seem that the larger ones are typical either of older plants or plants growing in more favorable habitats or both

Caulerpa sertularioides (Gmelin) Howe f *longiseta* (Bory) Svedelius has in the past been incorrectly cited as *C sertularioides* f *longiseta* (J Agardh) Svedelius, but the term *longiseta* was first used by Bory (1826, p 194) for var β *Longiseta* under *Caulerpe plumaire*, a synonym of *Caulerpa sertularioides*

Provisionally assigned here are *Bartlett 13940*, *Kostermans 467b*, and *Kostermans 586*, which resemble f *longiseta* more than they do any other form, but in which the ramuli are relatively wider and the fronds show the interrupted character usually ascribed to periodic growth

8 *Caulerpa serrulata* (Forsskål) J Agardh emend Børgesen

References — *Fucus serrulatus* Forsskål, 1775, p 189 *Caulerpa Freycinetii* C Agardh, 1822, p 446, Weber-van Bosse, 1898, p 310, pl 25, figs 4–11, pl 26, figs 1–6, 1913, p 102, Svedelius, 1906, p 115, Okamura, 1913, 3 (1) 18, pl 105, figs 1–6 *C serrulata* J Agardh, 1836, p 174 (not seen, quoted from Weber-van Bosse, 1898, p 311) *C serrulata* (Forsskål) J Agardh emend Børgesen, 1932b, p 5, 1940, p 50, Tseng, 1936a, p 178, fig 31

Distribution — Widely distributed in Indian and tropical Pacific waters

This species is well represented in the collections, with two varieties and several different forms, listed below In addition, two specimens from Java (*Kostermans 179*, Kaliage, Thousand Islands, Oct , *323*, Poeloe Tjina, Thousand Islands, Oct) were too fragmentary to assign to any particular variety The frequency of its occurrence in the Philippine material makes it surprising that the species has previously been recorded but a single time for the islands (Weber–van Bosse, 1913, p 102)

Var *typica* (Weber–van Bosse) Tseng

Reference — Tseng, 1936a, p 178

F *lata* (Weber-van Bosse) Tseng

Reference — Tseng, 1936a, p 178, fig 31

Collections — PHILIPPINES *Santos 128*, Wawa, Nasugbu, Batangas Province, July *Bartlett 13937*, Puerto Galera Bay, Puerto Galera, Mindoro, May, *14971*, Currimao, Ilocos Norte Province, Luzon, Oct, *15593a*, small island opposite Culion Harbor, Culion Island, Calamian Group, July, *16145*, Little Santa Cruz Island, Basilan Strait, southwest of Zamboanga, Mindanao, Sept, *16174*, Mactan Island, opposite Cebu, Cebu Island, Sept *Merrill 9155*, Taytay, Palawan, April *McGregor*, *Bureau of Science 18480*, Biliran, June *Hallier 588*, Zamboanga, Mindanao, Feb JAVA *Kostermans 12*, Eil Kerkhof, Bay of Batavia, Sept, *79*, Eil Leiden, Bay of Batavia, Sept, *265*, Eil Kelapa, Thousand Islands, Oct, *413*, Eil Amsterdam, near Bay of Batavia, Oct, *469*, Poeloe Pajoeng, Oct, *612*, Anjer, west coat of Java, Oct

F **serrulata** (Forsskal), comb nov

Reference — *Caulerpa Freycinetii* var *typica* f *serrulata* Weber-van Bosse, 1898, p 314

Collections — PHILIPPINES *Merrill 9142*, Taytay, Palawan, April JAVA *Kostermans 50*, Eil Hoorn, Bay of Batavia, Sept

F **spiralis** (Weber-van Bosse), comb nov

Reference — *Caulerpa Freycinetii* var *typica* f *spiralis* Weber-van Bosse, 1898, p 314

Collections — JAVA *Kostermans 49*, Eil Hoorn, Bay of Batavia, Sept, *112*, Eil Edam, Bay of Batavia, Sept, *587*, Poeloe Toenda (P Babi), Oct

Var **Boryana** (J Agardh), comb nov

References — *Caulerpa Boryana* J Agardh, 1872, p 20 *C Freycinetii* var *de Boryana* Weber van Bosse, 1898, p 315

F **occidentalis** (Weber-van Bosse), comb nov

Reference — *Caulerpa Freycinetii* var *de Boryana* f *occidentalis* Weber-van Bosse, 1898, p 315

Collections — PHILIPPINES *Bartlett 15577*, small island opposite Culion Harbor, Culion Island, Calamian Group, July, *16032b*, Siasi Island, Sulu Archipelago, Sept

F **longifolia,** f nov

(Figures 4–5, p 10)

Dentes tam longi quam latitudo rhachium

Collection — PHILIPPINES *Bartlett 16032a,* type, Siasi Island, Sulu Archipelago, Sept

This new form of var *Boryana* exhibits the characteristics of the variety, with the fronds having a long cylindrical pedicel and a flat linear blade, which is only slightly twisted, but it differs from other forms in the size and shape of the teeth, which are opposite to subopposite, somewhat spreading, reach a length equal to the width of the frond between the teeth bases, and are narrowed more or less sharply toward their pointed or mucronate tips The teeth of all other forms of var *Boryana* are wider at their base than high One of the fronds has teeth borne tristichously for a short distance, but this arrangement, though of rare occurrence, has already been shown in the species (Weber-van Bosse, 1898, p 316)

9 *Caulerpa cupressoides* (Vahl) C Agardh

References — *Fucus cupressoides* Vahl, 1802, p 29 *Caulerpa cupressoides* (Vahl) C Agardh, 1822, p 441, Agardh, J, 1872, p 21, Weber–van Bosse, 1898, p 323, pl 27, figs 1–14, pl 28, figs 1–12, 1913, p 103, Svedelius, 1906, p 115, Børgesen, 1913, p 135, figs 108–116, 1940, p 50, Okamura, 1916, 4 (1) 16, pl 155, figs 1–3, Taylor, 1928, p 96, pl 12, figs 18–19, pl 13, figs 4, 16, Tseng, 1936a, p 177, fig 30

Distribution — Widely distributed in tropical waters

Var *typica* Weber–van Bosse

Reference — Weber–van Bosse, 1898, p 327

Collection — JAVA *Kostermans 721*, Lampoeng Bay, Sumatra, Oct

Var *Lycopodium* (J Agardh) Weber–van Bosse

Reference — Weber–van Bosse, 1898, p 335

F *alternifolia* (Crouan) Weber–van Bosse

Reference — Weber–van Bosse, 1898, p 336

Collection — JAVA *Kostermans 466*, Poeloe Pajoeng, Oct

F *elegans* (Crouan) Weber-van Bosse

Reference — Weber-van Bosse, 1898, p 336

Collections — JAVA *Kostermans 183*, Kaliage, Thousand Islands, Oct, *262*, *263b*, Eil Kelapa, Thousand Islands, Oct, *588*, Poeloe Toenda (P Babi), Oct

F *amicorum* (Harvey) Weber-van Bosse

Reference — Weber-van Bosse, 1898, p 337

Collection — PHILIPPINES *Bartlett 13781*, Puerto Galera Bay, vicinity of Puerto Galera, Mindoro, May

This is the only specimen of *Caulerpa cupressoides* in the Philippine collection The ramuli throughout the plant are distichous, with no indication of a tristichous or multiseriate arrangement, but the branches, with a few exceptions, are produced on a third plane, which is not unusual for the species The conception of f *amicorum* of Tseng (1936a, p 177, fig 30) and Okamura (1916, 4[1] 16) suggests very strongly the length, shape, and arrangement of the ramuli of the Philippine specimen, except that these authors report that the ramuli are at times tristichous, or even multiseriate

? Var *ericifolia* (Turner) Weber-van Bosse

Reference — Weber-van Bosse, 1898, p 335

Collection — JAVA *Kostermans 609*, Anjer, west coast of Java, Oct

The specimen is so small and fragmentary that it is assigned to this variety with hesitation, the ramuli, however, are multiseriate and cylindrical, and some of them lie closely appressed to the central axis of the frond, which are characters of the variety

10 *Caulerpa racemosa* (Forsskål) J Agardh

References — *Fucus racemosus* Forsskål, 1775, p 191 *Caulerpa racemosa* (Forsskål) J Agardh, 1872, p 35, Dickie, 1876, p 244 (as *C clavifera*), Weber-van Bosse, 1898, p 357, pl 31, figs 5–8, pl 32, figs 1–7, pl 33, figs 1–23, 1913, p 104, figs 26–28, Børgesen, 1907, p 378, Okamura, 1913, 3 (4) 66, pl 119, figs 1–5; 1931, 6 (6) 58, pl 280, figs 2–9; Taylor, 1928, p 101, pl 12, figs 3, 5–6, 8, 14, pl 13, figs 3, 8–11, Yamada, 1934, p 71, Tseng, 1936a, p 180, fig 32

Distribution — Widely distributed in tropical waters

This species is abundant in the collections studied, but its very abundance made separation of the specimens into varieties and forms difficult, since the transition forms seem to be almost as numerous as the collections The need for critical field notes was especially felt here

Var *microphysa* (Weber–van Bosse) Taylor

Reference — Taylor, 1928, p 102
Collections — JAVA *Kostermans 468*, Poeloe Pajoeng, Oct , *589*, Poeloe Toenda (P Babi), Oct

The fronds are 3–15 mm in length and unbranched, the shorter ones with only three or four ramuli, the longer ones with many The ramuli have a short pedicel, occasionally as much as 1 mm long, which suddenly expands into a globular head 1 0–1 5 mm in diameter At times there is a suggestion of a constriction between the globular head and the pedicel of the ramulus, which may indicate some relationship between var *microphysa* and the Pedicellatae of J Agardh However, neither of the two specimens shows the marked constriction characteristic of all the Pedicellatae, including *Caulerpa lentillifera*, which *C racemosa* var *microphysa* otherwise rather closely resembles

Var *clavifera* (Turner) Weber–van Bosse

Reference — Weber–van Bosse, 1898, p 361
Collections — PHILIPPINES *Santos 129*, Wawa, Nasugbu, Batangas Province, July *Bartlett 13942*, Puerto Galera Bay, vicinity of Puerto Galera, Mindoro, May, *14004*, Batangas Channel, Puerto Galera, Mindoro, *14976*, Dalupiri Island, Babuyan Group, Nov , *15420*, Basco, Batan Island, Batanes Province, July, *16052*, Harbor of Jolo, Jolo Island, Sulu Archipelago, Sept , *16144*, Little Santa Cruz Island, Basilan Strait, near Zamboanga, Mindanao, Sept *Merrill 9139*, Taytay, Palawan, April, *9162*, Taytay, Palawan, May *Shaw 1128, 1129*, Cabcaban, Province of Bataan, Luzon, May *Williams* (no collection number), on coral reef, Darong, Mindanao, March 21, 1905 *Fénix, Bureau of Science 13006*, Puroton Reef, San Fernando, La Union Province, Luzon, Dec *Curran, Forestry Bureau 9560*, Piapi, Tayabas Province, Luzon, March *Albatross Expedition 7, 9* JAVA · *Kostermans 5*, Eil Kerkhof, Bay of Batavia, Sept , *52*, Eil. Hoorn, Bay of Batavia, Sept , *111*, Eil Edam, Bay of Batavia,

Sept., *266*, Eil Kelapa, Thousand Islands, Oct., *412*, Eil Amsterdam, near Bay of Batavia, Oct., *472*, Poeloe Pajoeng, Oct.

Included here are those specimens with fronds up to 3 cm. in length, the ramuli being more or less spaced and consisting of a lower portion, 0.5–1.0 mm. in length, which gradually expands into a rounded end, 2.3 mm. in diameter. In a few, particularly *Bartlett 13942*, some of the ramuli have rather longer pedicels and quite suddenly expand into the globular tip, thus suggesting var. *occidentalis*, but because the condition is not uniform throughout the whole plant and because the fronds are shorter than typical var. *occidentalis* the specimens are included here.

Var. *macrophysa* (Kützing) Taylor

Reference. — Taylor, 1928, p. 101.

Collections. - PHILIPPINES: *Bartlett 16126a*, *16129*, North Ubian Island, Sulu Archipelago, Sept. JAVA: *Kostermans 4*, Eil Kerkhof, Bay of Batavia, Sept., *180*, *182*, *192*, Kaliage, Thousand Islands, Oct., *267*, Eil Kelapa, Thousand Islands, Oct., *322*, Poeloe Tjina, Thousand Islands, Oct., *613*, Anjer, west coast of Java, Oct., *720*, Seboekoe, Lampoeng Bay, Sumatra, Oct.

The fronds reach 4 cm. in length. The ramuli expand rather suddenly into a spherical or, more rarely, a flattened end 3–5 mm. in diameter, and are from 3 mm. (or less) to 5 mm. apart.

It is interesting that the usual form of the ramuli tips is spherical rather than "depressed-convex," as Taylor (1928, p. 101) describes the Florida material. That the typical form is rounded there can be little doubt, for the figure of *Chauvinia macrophysa* Kützing (1857, pl. 15) from the coast of Central America, on which Weber-van Bosse based her f. *macrophysa* and Taylor based the variety, shows most of the ramuli spherical, with a few compressed; this is characteristic of the Javanese and Philippine material.

Okamura (1913, pl. 119, fig. 1) in illustrating his conception of *Caulerpa racemosa* var. *clavifera* f. *macrophysa* shows a plant with the ramuli having almost spherical ends, only an occasional one being depressed. His illustration is of a plant strikingly similar to several of the present collections.

What appears to be a transition form between varieties *macrophysa* and *laetevirens* is represented by *Kostermans 192*; *Bartlett 16126b* shows certain affinities to var. *occidentalis*.

Var *macra* Weber-van Bosse

Reference — Weber-van Bosse, 1913, p 106, fig 26
Collections — PHILIPPINES *Bartlett 15576*, small island opposite Culion Harbor, Culion Island, Calamian Group, July JAVA *Kostermans 110*, Eil Edam, Bay of Batavia, Sept, *191*, Kaliage, Thousand Islands, Oct, *268*, Eil Kelapa, Thousand Islands, Oct

Weber-van Bosse described this variety to accommodate a large and robust specimen of *Caulerpa racemosa*, which was found growing in very quiet water The plants in the present collections reach the dimensions given for the variety, especially *Bartlett 15576*, which has a stolon up to 6 mm in diameter and more than 40 cm long and fronds 5-11 cm in length The ramuli are almost entirely pyriform, swelling sometimes abruptly, but more often gradually, from the base to the rounded tip Some of the ramuli reach a length of a little more than a centimeter, are arranged alternately, and are not crowded

It is quite impossible to ascertain whether the specimens listed above were found in quiet waters

Var *uvifera* (Turner) Weber-van Bosse

Reference — Weber van Bosse, 1898, p 362
Collection — PHILIPPINES *Albatross Expedition 38*

The one specimen is largely characterized by the multiseriate and imbricate obovoid or obovoid-compressed ramuli of var *uvifera*, but shows some affinity to var *laetevirens*, since some of the ramuli are cylindrical or elongate-clavate

Var *corynephora* (Montagne) Weber-van Bosse

Reference — Weber-van Bosse, 1898, p 364
Collections — PHILIPPINES *Albatross Expedition 8, 29*

? Var *occidentalis* (C Agardh) Børgesen

Reference — Børgesen, 1907, p 379
Collection — JAVA *Kostermans 80*, Eil Leiden, Bay of Batavia, Sept

It is with hesitation that this specimen is included here, but since the ramuli appear alternate and somewhat distichous, are not

crowded, and are suddenly swollen into a rounded tip from a fairly long pedicel, the plant seems to belong to this rather than to any other variety

Var *laetevirens* (Montagne) Weber-van Bosse

Reference — Weber-van Bosse, 1898, p 366
Collections — PHILIPPINES *Albatross Expedition 64* JAVA *Kostermans 193*, Kaliage, Thousand Islands, Oct , *269*, Eil Kelapa, Thousand Islands, Oct , *471*, Poeloe Pajoeng, Oct

The Javanese specimens have fronds up to 5–6 cm high, with the typical densely imbricate ramuli, which are gradually swollen to a rounded summit The fronds of the Philippine specimen reach 13 cm in height, the ramuli are elongate-cylindrical and as much as 1 cm long

Var *Lamourouxii* (Turner) Weber–van Bosse

Reference — Weber–van Bosse, 1898, p 368
Collections — JAVA *Kostermans 3*, Eil Kerkhof, Bay of Batavia, Sept , *81*, Eil Leiden, Bay of Batavia, Sept , *190*, Kaliage, Thousand Islands, Oct , *411*, Eil Amsterdam, near Bay of Batavia, Oct , *590*, Poeloe Toenda (P Babi), Oct

All the specimens are f *typica* Weber -van Bosse, and vary from plants with a complanate frond almost destitute of ramuli to ones with fronds consisting of an erect axis which is almost cylindrical and having numerous, but not crowded, distichous cylindrical or clavate ramuli

Var *gracilis* (Zanardini) Weber-van Bosse

Reference — Weber–van Bosse, 1898, p 370
Collection — PHILIPPINES *Albatross Expedition 34*

Var *Chemnitzia* (Esper) Weber–van Bosse

Reference — Weber–van Bosse, 1898, p 370
Collections — JAVA *Kostermans 325*, Poeloe Tjina, Thousand Islands, Oct , *530*, Toppershoedje, an island between Strait Soenda and Java Sea, Oct

The plants are rather delicate, with fronds up to 2 cm in height The ramuli are numerous and imbricate, trumpet-shaped, enlarging gradually from the base to the flattened top

11 *Caulerpa peltata* Lamouroux

References — Lamouroux, 1809, p 145, pl 3, fig 2 (not seen, quoted from Weber–van Bosse, 1898, p 373), Agardh, J , 1872, p 37, Dickie, 1876, p 244, Weber–van Bosse, 1898, p 373, pl 31, figs 9–11, pl 32, figs 8–9, 1913, p 110, Svedelius, 1906, p 131, Børgesen, 1925, p 112, fig 47, 1932a, p 62, fig 5, Okamura, 1931, 6 (6) 60, pl 280, figs 10–12, Yamada, 1934, p 72, Tseng, 1936b, p 176, fig 4

Distribution — Widely distributed in tropical waters

In this species have been included all those specimens with few to all peltate ramuli Transition forms are found in the specimens listed under var *typica*, they vary from plants in which all ramuli are peltate to ones in which only a few of the ramuli are typically peltate and the others range in shape to the clavate form of *Caulerpa racemosa* var *clavifera*, the trumpet-like and imbricate ramuli of *C racemosa* var *Chemnitzia*, or the suddenly expanded spherical-tipped ramuli of *C racemosa* var *occidentalis*

All these transition forms may at times be found on the same plant and largely even on the same frond This serves to illustrate once again that the line distinguishing *Caulerpa peltata* from *C racemosa* is apparently quite arbitrary The writer feels, however, that it is best to retain them as separate species, although acknowledging the evidence which shows they may not be, until the degree of hybridization in the genus Caulerpa is better understood Cultural investigation should prove a most valuable aid to systematic studies in this genus

Var *typica* Weber–van Bosse

Reference — Weber–van Bosse, 1898, p 375

Collections — PHILIPPINES *Santos 127*, Wawa, Nasugbu, Batangas Province, July *Bartlett 13943*, Puerto Galera Bay, Puerto Galera, Mindoro, May, *14975*, Dalupiri Island, Babuyan Group, Nov , *16126b*, *16127*, North Ubian Island, Sulu Archipelago, Sept JAVA *Kostermans 178*, Kahage, Thousand Islands, Oct , *470*, Poeloe Pajoeng, Oct , *529*, *531*, Toppershoedje, Oct , *664*, Oedjoengkoelon, western cape of Java, Oct ; *718*, *719*, Seboekoe, Lampoeng Bay, Sumatra, Oct

The average diameter of the peltate tips is about 3 mm, which is typical for the variety, but in *Bartlett 16127* the diameter reaches 6 mm, almost the maximum for the variety

Var *macrodisca* (Decaisne) Weber-van Bosse

Reference — Weber-van Bosse, 1898, p 376

Collection — JAVA *Kostermans 758*, Belimbing, on the south coast of Sumatra, Oct

Only one specimen at hand represents this variety The diameter of the peltate tips of some of the ramuli reaches 1 0 cm The ramuli are comparatively few and widely spaced Variety *macrodisca* has also been reported from the Philippines (Howe, 1932, p 169), from Panay Island, under the name *Caulerpa macrodisca* Decaisne This collection, which the writer has seen, has specimens with peltate ramuli which exceed 2 cm in diameter

12 *Caulerpa lentillifera* J Agardh

References — Agardh, J, 1836, p 173 (not seen, quoted from De Toni 1889, 1 483), 1872, p 42, Weber-van Bosse, 1898, p 380, pl 34, figs 1–2, 1913, p 112 *Caulerpa longistipitata* (Weber-van Bosse) Svedelius, 1906, p 137, figs 45–46

Distribution — Japan, China Sea, Polynesia, Malay Archipelago, Indian Ocean, ? Caribbean

Collections — PHILIPPINES *Bartlett 13941*, Puerto Galera Bay, Puerto Galera, Mindoro, May JAVA ? *Kostermans 181*, Kaliage, Thousand Islands, Oct

The constriction of the ramulus pedicel characteristic of this and other species of the Pedicellatae, is not so evident in the Javanese plant, but the length of the frond, the long pedicels of the ramuli, and the constriction, though slight, would seem to indicate that it should be placed here, rather than in *Caulerpa racemosa* var *microphysa*, to which it bears certain resemblances

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NOTES ON THE ALGAL FLORA OF MICHIGAN *

ALTON H. GUSTAFSON

TAXONOMIC studies of the Michigan algae have been published at intervals since 1894 (19). Ackley (2) and Nichols and Ackley (17) compiled a list of 950 species, varieties, and forms found in the state. Investigation has been particularly active in the last decade, as is shown by the bibliography at the end of this paper and the fact that 1,433 species have now been listed. This is a greater number than is known from any other state.

Material for the study reported here was gathered in Charlevoix, Cheboygan, Emmet, Otsego, and Presque Isle counties. Twenty-one species (marked with asterisks in the list below) are new to the state; eighty-two are listed for a second time.

Table I is a census of the known algae, exclusive of the diatoms, arranged in taxonomic groups; it shows that certain groups have not been adequately studied and that most of the species have been reported but once. Records for the flagellated groups are especially scarce. Even the group best represented, the Desmidiaceae, which accounts for about 40 per cent of the total number of species, should have considerably more attention, as is indicated by the fact that nearly half of the known species have been reported since the publication of the summary paper by Nichols and Ackley (17) in 1932. Since more than 70 per cent of all known species have been recorded by only one observer there is obvious need of confirmatory data.

Present interest in the algae, coupled with the fact that some papers have been overlooked by previous investigators, warrants the inclusion of a complete bibliography of articles on the Michigan algae, exclusive of those concerned solely with diatoms.

* Thanks are due the Williams College 1900 Fund for financial assistance and the University of Michigan Biological Station for the privileges and courtesies extended during the course of the investigation.

TABLE I

CENSUS OF ALGAE KNOWN FROM MICHIGAN, INCLUDING SPECIES, VARIETIES, AND FORMS, ARRANGED IN TAXONOMIC GROUPS

Group	Number previously reported				Number reported in this paper	
	Once	Twice	More than twice	Total	For the first time	For the second time
Myxophyceae	191	34	26	251	3	28
Chrysophyceae	16	6	2	24	4	4
Heterokontae	15	5	3	23	1	5
Dinophyceae	11	1	1	13		
Cryptophyceae					2	
Rhodophyceae	2	1		3		
Charophyceae	18	3		21		
Euglenophyceae	9	2	2	13	6	5
Chlorophyceae	(743)	(210)	(111)	(1,064)		
Volvocales	7	1	4	12	1	1
Tetrasporales	11	6		17	1	8
Ulotrichales	56	21	8	85		6
Oedogoniales	91	23	2	116		
Chlorococcales	120	20	17	157	3	25
Siphonales	7	5	2	14		
Zygnematales	(451)	(134)	(78)	(663)		
Zygnemataceae	59	24	5	88		
Mesotaeniaceae	21	2	1	24		
Desmidiaceae	371	108	72	551		
Totals	1,005	262	145	1,412	21	82

LIST OF SPECIES

MYXOPHYCEAE

CHROOCOCCALES

APHANOCAPSA DELICATISSIMA W and G S West — Abundant in Tomahawk Lakes, Presque Isle, Ackley (2)

APHANOCAPSA RIVULARIS (Carm) Rabenh — Emmet and Charlevoix, Ackley (2)

APHANOTHECE CLATHRATA W and G S West — Cheboygan, Welch (43)

APHANOTHECE NIDULANS Richter — Cheboygan and Emmet, Ackley (2)

CHROOCOCCUS GIGANTEUS W West — Emmet and Charlevoix, Ackley (2)

GLEOCAPSA GIGAS W and G S West — Cheboygan and Emmet, Ackley (2)

GLOEOTHECE LUNATA W and G S West — Emmet, Ackley (2)

GOMPHOSPHAERIA LACUSTRIS Chodat — Cheboygan and Emmet, Ackley (2)

MARSONIELLA ELEGANS Lemm — Emmet, Charlevoix, and Otsego, Taft (29)

MERISMOPEDIA PUNCTATA Meyen — Emmet and Otsego, Ackley (2)

*SYNECHOCOCCUS AERUGINOSUS Näg — Cheboygan

*SYNECHOCOCCUS AERUGINOSUS Näg var MAXIMUS Lemm — Shoepack Lake, Presque Isle

CHAEMOSIPHONALES

*XENOCOCCUS RIVULARIS (Hansg) Geitler — Nichol's Bog, Cheboygan

The identification is open to some question, although similar material from the same locality has been provisionally assigned to this species by Dr G E Nichols, of Yale University

HORMOGONALES

ANABAENA CONTORTA Bach — Emmet, Ackley (2)

ANABAENA INAEQUALIS (Kütz) Bornet and Flahault — Cheboygan and Emmet, Ackley (2)

ANABAENA LEMMERMANNI Richter — Cheboygan and Otsego, Ackley (2)

ANABAENA LIMNETICA G M Smith — Otsego, Raymond (25)

ANABAENA TORULOSA (Carm) Lagerh — Cheboygan and Emmet, Ackley (2)

CALOTHRIX PARIETINA (Näg) Thuret — Cheboygan, Emmet, and Charlevoix, Ackley (2)

CYLINDROSPERMUM MINUTUM Wood — Emmet, Ackley (2)

DICOTHRIX ORSIANA (Kütz) Bornet and Flahault — Presque Isle, Ackley (2)

HAPALOSIPHON FONTINALIS (Ag) Bornet — Cheboygan and Emmet, Ackley (2)

LYNGBYA AERUGINEO-COERULEA (Kütz) Gom — Cheboygan, Ackley (2)
LYNGBYA MAJOR Menegh — Presque Isle, Ackley (2)
LYNGBYA MAJUSCULA (Dillwyn) Harvey — Cheboygan and Charlevoix, Ackley (2)
MICROCOLEUS PALUDOSUS (Kütz) Gom — Otsego, Velasquez (41)
NODULARIA PALUDOSA Wolle — Presque Isle, Ackley (2)
NOSTOC MICROSCOPICUM Carm — Emmet and Otsego, Ackley (2)
NOSTOC PUNCTIFORME (Kutz) Hariot — Otsego, Ackley (2)
PHORMIDIUM RETZII (Ag) Gom — Emmet, Velasquez (41)
SCYTONEMA HOFMANNI Ag — Cheboygan, Ackley (2)

CHRYSOPHYCEAE

*CHRYSAMOEBA RADIANS Klebs — Cheboygan
CHRYSOCAPSA PLANCTONICA (W and G S West) Pascher — Emmet and Charlevoix, Taft (29)
*DEREPYXIS URCEOLATA (Stokes) Lemm — Presque Isle
The identification of this species is somewhat doubtful because of the small number of individuals found
LAGYNION AMPULLACEUM (Stokes) Pascher — Common epiphyte on other algae in Charlevoix, Taft (29)
MALLOMONAS CAUDATA Iwanoff — Cheboygan and Emmet, Taft (29)
*MALLOMONAS TONSURATA Teilung — Rather abundant in several plankton samples taken from Emmet
*SYNCRYPTA VOLVOX Ehr — Found in several collections from roadside ditches in Presque Isle
This species was identified by Dr Nichols from collections made in 1933 in Vincent Lake, although no record was published
UROGLENA VOLVOX Ehr — Charlevoix and Otsego, Kofoid (15)

HETEROKONTAE

*CENTRITRACTUS BELENOPHORUS Lemm — Emmet and Otsego
There appears to be no previously published record of the occurrence of this species in the United States, although Dr James B Lackey, of the United States Public Health Service, Cincinnati, Ohio, has found it to be abundant in Ohio, and the author has collected it in Massachusetts

OPHIOCYTIUM ARBUSCULUM (A Braun) Rabenh — Charlevoix and Emmet, Ackley (2)

OPHIOCYTIUM CAPITATUM Wolle — Emmet and Presque Isle, Ackley (2)

OPHIOCYTIUM MAJUS Näg — Cheboygan, Emmet, Charlevoix, and Presque Isle, Ackley (2)

OPHIOCYTIUM PARVULUM (Perty) A Braun — Present in collections from all counties studied, Ackley (2)

STIPITOCOCCUS URCEOLATUS W and G S West — Otsego and Presque Isle, Taft (29)

CRYPTOPHYCEAE

*CRYPTOMONAS EROSA Ehr — Emmet, Charlevoix, and Presque Isle

*CRYPTOMONAS OVATA Ehr — Cheboygan, Charlevoix, Emmet, and Presque Isle

EUGLENOPHYCEAE

*EUGLENA DESES Ehr — Occasional in plankton, Cheboygan

EUGLENA OXYURIS Schmarda — Occasional in vegetable débris in roadside ditches, Cheboygan and Emmet, Dolley (13)

*LEPOCINCLIS OVUM (Ehr) Lemm — Presque Isle

PHACUS ACUMINATUS Stokes — Cheboygan and Emmet, Taft (29)

PHACUS PLEURONECTES (O F M) Duj — Roadside pools, Emmet and Presque Isle, Ackley (2)

PHACUS PYRUM (Ehr) Stein — Cheboygan and Emmet, Taft (29)

*PHACUS TRIQUETER (Ehr) Duj — Otsego

*TRACHELOMONAS CREBEA Kellicott — Charlevoix and Otsego

TRACHELOMONAS HISPIDA (Perty) Stein — Emmet and Presque Isle, Taft (29)

*TRACHELOMONAS URCEOLATA Stokes — Otsego

*TRACHELOMONAS VOLVOCINA Ehr — Otsego

CHLOROPHYCEAE

VOLVOCALES

*CARTERIA CORDIFORMIS (Carter) Diesing — Cheboygan and Emmet

PLEODORINA CALIFORNICA Shaw — Emmet, Dolley (13)

TETRASPORALES

*APIOCYSTIS BRAUNIANA Näg var LINEARIS Rabenh — In several collections from Carp River, Emmet, always in association with the species

Individuals of the species were larger than those usually found elsewhere, the colonies frequently exceeding 800 microns in length

ASTEROCOCCUS LIMNETICUS G M Smith — Emmet and Presque Isle, Ackley (2)

ASTEROCOCCUS SUPERBUS (Cienk) Scherffel — Found frequently in collections from Cheboygan, Emmet, and Charlevoix, reported rare by Ackley (2)

ELAKATOTHRIX VIRIDIS (Snow) Printz — Cheboygan and Emmet, Taft (29)

GLOEOCYSTIS AMPLA Kütz — Cheboygan and Emmet, Taft (29)

GLOEOCYSTIS LIMNETICUS G M Smith — Emmet, Ackley (2)

GLOEOCYSTIS VESICULOSA Näg — Cheboygan and Emmet, Ackley (2)

SPHAEROCYSTIS SCHROETERI Chodat — Common in plankton of ponds and lakes in Cheboygan and Emmet, Ackley (2)

TETRASPORA GELATINOSA (Vauch) Desvaux — Cheboygan, Emmet, Charlevoix, Otsego, and Presque Isle, Ackley (2)

ULOTRICHALES

APHANOCHAETE VERMICULOIDES Wolle — Cheboygan, Taylor (30)

CHAETOSPHAERIDIUM GLOBOSUM (Nordst) Klebahn — Cheboygan and Emmet, Ackley (2)

DRAPARNALDIA GLOMERATA (Vauch) Ag — Cheboygan, Ackley (2)

MICROTHAMNION KUETZINGIANUM Näg — Cheboygan, Taft (29)

RADIOFILUM CONJUNCTIVUM Schmidle — Cheboygan, Taft (29)

STICHOCOCCUS BACILLARIS Näg — Cheboygan, Ackley (2)

CHLOROCOCCALES

ANKISTRODESMUS FALCATUS (Corda) Ralfs var MIRABILIS (W and G S West) G S West — Emmet, Taylor (30)

ANKISTRODESMUS SPIRALIS (Turner) Lemm — Cheboygan and Emmet, Ackley (2)

CHARACIUM AMBIGUUM Herman — Cheboygan and Presque Isle, Ackley (2)

CHARACIUM STIPITATUM (Bachm) Wille — Cheboygan, Ackley (2)
CHLORELLA VULGARIS Beyerinck — Emmet and Otsego, Ackley (2)
CHLOROCOCCUM INFUSIONUM (Schrank) Menegh — Otsego, Ackley (2)
*COELASTRUM SPECIOSUM (Wolle) Brunnthaler — Cheboygan
CRUCIGENIA APICULATA (Lemm) Schmidle — Emmet and Otsego, Taft (29)
CRUCIGENIA QUADRATA Morren — Cheboygan, Ackley (2)
FRANCEIA DROESCHERI (Lemm) G M Smith — Presque Isle, Taft (29)
GOLENKINIA RADIATA Chodat — Emmet and Otsego, Taft (29)
*LAGERHEIMIA QUADRISETA (Lemm) G M Smith - Emmet
NEPHROCYTIUM LIMNETICUM G M Smith — Emmet, Ackley (2)
PEDIASTRUM BIRADIATUM Meyen — Cheboygan, Ackley (2)
SCENEDESMUS ABUNDANS (Kirchner) Chodat — Cheboygan, Emmet, Otsego, Ackley (2)
SCENEDESMUS ACUMINATUS (Lagerh) Chodat — Emmet, Ackley (2)
SCENEDESMUS ACUTIFORMIS Schroeder — Emmet, Taft (29)
SCENEDESMUS ARCUATUS Lemm — Emmet, Ackley (2)
SCENEDESMUS QUADRICAUDA (Turp) Breb var MAXIMUS W and G S West — Cheboygan and Emmet, Taft (29)
SCENEDESMUS QUADRICAUDA (Turp) Breb var QUADRISPINA (Chodat) G M Smith — Cheboygan and Emmet, Ackley (2)
SELENASTRUM MINUTUM (Näg) Collins — Cheboygan, Ackley (2)
SORASTRUM AMERICANUM (Bohlin) Schmidle — Cheboygan and Charlevoix, Taft (29)
TETRAEDRON ENORME (Ralfs) Hansg — Cheboygan, Taft (29)
*TETRAEDRON TRIGONUM (Nag) Hansg — Presque Isle
TETRASTRUM HETEROCANTHUM (Nordstedt) Chodat — Emmet, Ahlstrom and Tiffany (4)
TROCHISCIA OBTUSA (Reinsch) Hansg — Cheboygan and Presque Isle, Ackley (2)
TROCHISCIA RETICULARIS (Reinsch) Hansg — Cheboygan, Ackley (2)
WESTELLA BOTRYOIDES (W West) de Wildeman — Cheboygan and Emmet, Ackley (2)

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THE ATLANTIC COASTAL PLAIN ELEMENT IN THE FLORA OF KALAMAZOO COUNTY, MICHIGAN

CLARENCE R. HANES

THE Atlantic Coastal Plain species of plants are primarily restricted to the coastal plain from Newfoundland to Florida. Several, however, are found in limited areas in central New York and along the shores of Lake Erie, in the southeastern part of Michigan and in the Grand Rapids region, and especially near the southern end of Lake Michigan in southwestern Michigan and northern Indiana. It is around the southern end of Lake Michigan that they occur in the greatest profusion.

The purpose of this paper is not to explain how or why the plants have come to be in these inland locations, but to present a record of those found in Kalamazoo County and to give their distribution. It is a local treatment intended to make the material accessible to anyone who may in the future wish to devote further study to plants of this type.

It should not be out of place, however, to state that in several papers dealing with the subject evidence has been brought forth to show that the route of migration was along the Hudson-Mohawk Valley, then along the Great Lakes, and finally across Michigan by the Grand River Valley. All this inland penetration occurred, of course, when the lakes and streams had confines much different from the present ones. Recent discoveries of the Atlantic Coastal Plain element in Wisconsin, Minnesota, and Iowa have led some botanists to believe that more of these species came up from the south than had previously been supposed.

In our county these plants are found mainly on the sandy or muddy shores of small lakes and in ponds and marshes or on their borders. A few grow in wet woodlands and several on sandy uplands. *Echinochloa Walteri*, the only one that occurs along or near the Kalamazoo River, grows also on stream borders elsewhere in the county.

These species are restricted in great part to the southwest quarter of Kalamazoo County In this area are two zones, in each of which there is a congestion of this type of flora Zone 1 comprises the townships of Schoolcraft and Portage, the western sections of Brady and Pavilion townships, and White Lake, near the southern boundary of Kalamazoo Township Austin Lake is the nucleus of this zone Zone 2 is composed of Prairie Ronde and Texas townships and a part of Oshtemo Township, with Eagle Lake as its nucleus Now and then one or more plants of this class have been collected in scattered locations outside these two zones Stony Lake, in Ross Township, which is the northeastern township of the county, is an exception, since at least nine species grow in the neighborhood of this lake

The list of plants of this type given by Peattie in *Rhodora*[1] has been used as a guide in selecting those of Kalamazoo County that belong to the group Several others have been added, since their distribution appears to place them without question in this class There is some doubt, however, about the following five species, namely *Eleocharis pauciflora* var *Fernaldii*, *Rhexia virginica*, *Monardo punctata* var *villicaulis*, *Melampyrum lineare* var *latifolium*, and *Utricularia cornuta* The fact that these five plants which occur on the coast are found in Indiana only in the northern or northwestern part and in Kalamazoo County only in the two zones mentioned has led me to include them in this group

Specimens of all the species given in the following list have been collected during the past eight years by Mrs Florence N Hanes and the writer and are deposited in our herbarium Many duplicates have been distributed in various herbaria in the United States The order of locations in the list shows the relative abundance of the species collected

List of Species

WOODWARDIA VIRGINICA (L) Sm — Usually on the border of blueberry swamps in Schoolcraft, Portage, and Prairie Ronde townships One station outside the restricted area is in Section 8, Climax Township

NAJAS GRACILLIMA (A Br) Morong — Infrequent in Eagle and Pretty lakes Abundant in 1938 in Bonnie Castle Lake

[1] Peattie, D. C , "The Atlantic Coastal Plain Element in the Flora of the Great Lakes," *Rhodora*, 24 86–88 1922.

STIPA AVENACEA L — On wooded knolls near Sugarloaf, Dustin, and Goose lakes, Section 17, Oshtemo Township Outside the restricted area near Spring Brook in Richland Township

PANICUM MERIDIONALE Ashe — In marshes near West and Austin lakes, Eagle Lake, White Lake

PANICUM ALBEMARLENSE Ashe — Shores of Austin and West lakes, Stony Lake

ECHINOCHLOA WALTERI (Pursh) Heller — Along Flowerfield Creek, Prairie Ronde Township, and the outlet of Barton Lake, also along the Kalamazoo River both east and north of Kalamazoo

HEMICARPHA MICRANTHA (Vahl) Britt — On the sandy shores of Eagle, Pretty, Crooked, and Pine Island lakes, all in Texas Township, Bonnie Castle Lake in Oshtemo Township, West and Austin lakes in Portage Township, and Pickerel Lake in Pavilion Township

FUIRENA PUMILA Torr — Shores of Eagle, Crooked, Pine Island, and Weeds lakes in Texas Township, East Lake in Pavilion Township, and Stony Lake in Ross Township The species extends across the county, making jumps of several miles between stations

SCIRPUS DEBILIS Pursh var WILLIAMSII Fern — Shores of Eagle, Pine Island, and Bonnie Castle lakes In 1937 this species was found at Pretty Lake in several inches of water

SCIRPUS SMITHII Gray — Shores of Weeds and Pickerel lakes and on the east side of Austin Lake

ELEOCHARIS EQUISETOIDES (Ell) Torr — In shallow water at White Lake In the shallow water of Mud Lake, Portage Township, it covers several acres

ELEOCHARIS QUADRANGULATA (Michx) R & S var CRASSIOR Fern — Near the southeast shore of Pickerel Lake Here it grows in one foot or more of water, but after several dry seasons it thrives in the mud

ELEOCHARIS ROBBINSII Oakes — In shallow water or in mud in marshes west and southwest of West Lake

ELEOCHARIS MELANOCARPA Torr — On the east and the southeast shores of Austin Lake, Bonnie Castle and Pretty lakes Frequent in several stations around Eagle Lake It was first collected at Austin Lake in 1934 and was sent to H R Svenson for confirmation in 1937 This sedge has recently been collected by C W Bazuin in several localities near Grand Rapids

Peattie uses *E melanocarpa* as an example of the species which make the jump from the coast to the southern end of Lake Michigan in Indiana without being found at any intermediate points [2] These Kalamazoo County and Grand Rapids reports supply at least two intermediate stations

ELEOCHARIS ROSTELLATA Torr — In wet marshes around Sugarloaf, Bonnie Castle, and Pawpaw lakes it is abundant Outside the restricted zones it is found near Lyon and Three Lakes and at Cold Springs, Alamo Township

ELEOCHARIS PAUCIFLORA (Lightf) Link var FERNALDII Svenson — In marly soil near the shore of Pawpaw Lake

FIMBRISTYLIS AUTUMNALIS (L) R & S var MUCRONULATA (Michx) Fern — Shores of Eagle, Harrison, White, Weeds, West, Austin, Pickerel, Dustin, and Stony lakes

PSILOCARYA SCIRPOIDES Torr — Shores of Eagle and Stony lakes, marsh near West Lake, marsh bordering Mud Lake, Texas Township

RHYNCHOSPORA MACROSTACHYA Torr — In marshes west and southwest of West Lake, "Island" marsh near the village of Schoolcraft, Weeds, Mud, Eagle, and Crooked lakes, all in Texas Township On the eastern shore of Crooked Lake it is abundant in shallow water over an area of several acres

RHYNCHOSPORA FUSCA (L) Ait f — The only station known to us is in a swamp west of West Lake, where it grows abundantly in sphagnum

CAREX HOWEI Mack — In moist woods, often in water Two stations near Goose Lake, Schoolcraft Township, Section 32, Prairie Ronde Township

CAREX RICHII (Fern) Mack — Grows in large clumps in a swamp on the north boundary of Section 12 and on the south boundary of Section 1, Schoolcraft Township Also one mile north of this station on the north boundary of Section 1

CAREX LONGII Mack — In open or thinly wooded swamps Two stations each in Portage, Schoolcraft, and Pavilion townships We have collected it in Flowerfield Township, St Joseph County, and F W Rapp has found it in two localities in Brady Township

CAREX ALBOLUTESCENS Schwein — In thin low woodlands Section

[2] Peattie, *op cit*, pp 59–60

33, Portage Township, Section 1, Schoolcraft Township F W Rapp has found it in Section 31, Brady Township, and we have a collection from Portage Lake, St Joseph County

CAREX ALATA Torr — In open swamps Three stations in Portage Township, Section 32, Brady Township, and Section 22, Schoolcraft Township

CAREX EMMONSII Dewey — In poplar or blueberry swamps mainly in the open It is abundant northeast of Goose Lake and near the Jenkinson School in Brady Township It occurs also in Texas, Prairie Ronde, and Pavilion townships

PELTANDRA VIRGINICA (L) Kunth — Lakes or creeks in Portage, Schoolcraft, and Brady townships

XYRIS CAROLINIANA Walt — In swamps and on the boggy borders of lakes Near West, Austin, and Thrall lakes, Le Fevre Bog in Section 8, Climax Township We have collected this species at Pleasant Lake, Barry County

XYRIS TORTA Sm — In damp sandy soil on or near the shores of Eagle, Pretty, and Pine Island lakes

JUNCUS GREENEI Oakes & Tuckerm — On sandy lake shores East shore of Austin Lake and south shore of Eagle Lake

JUNCUS BALTICUS Willd var LITTORALIS Engelm f DISSITIFLORUS Engelm — On sandy lake shores and borders of swamps Shores of Eagle, Pretty, and Austin lakes Border of swamp east of Sugarloaf Lake

JUNCUS PELOCARPUS E Mey — On lake borders and in swamps Borders of Eagle, Austin, Pickerel, Bonnie Castle, and Stony lakes, swamp east of Gourdneck Lake

JUNCUS SCIRPOIDES Lam — Abundant on the sand dunes on the east shore of Austin Lake

JUNCUS BIFLORUS Ell — Near the bank of Vicksburg Creek, south of Vicksburg, in low thinly wooded meadow in Section 18, Texas Township We have also collected this species two miles north of Sturgis, in St Joseph County

QUERCUS PRINOIDES Willd — Frequent in the sandy parts of Portage, Texas, and Oshtemo townships, along roadsides, in thickets, and sometimes in fields

DROSERA INTERMEDIA Hayne — Near West and Pickerel lakes, on the south side of Pine Island Lake, in Le Fevre Bog, Section 8, Climax Township

LUPINUS PERENNIS L — Sandy soil of Portage, Pavilion, Texas, Kalamazoo, and Oshtemo townships

LINUM STRIATUM Walt — On the moist north and south shores of Bonnie Castle Lake

POLYGALA CRUCIATA L — In semimoist soil southwest of West Lake and west of Pine Island Lake in Section 18, Texas Township Very rare at the latter station

LECHEA MINOR L — In sandy soil east of Sugarloaf Lake and near the south shore of Eagle Lake

LECHEA LEGGETTII Britt & Holl var MONILIFORMIS (Bickn) Hodgdon — Sand dunes on the east shore of Austin Lake, where it is plentiful

ROTALA RAMOSIOR (L) Koehne var TYPICA Fern & Grisc — Makes an abundant growth on marshes which have recently been burnt over Marsh southwest of West Lake, swamp east of Gourdneck Lake, ditch south of Hogset Lake, Thrall and Eagle lakes

RHEXIA VIRGINICA L — Sandy borders of Eagle and Pine Island lakes Very scarce

HYDROCOTYLE UMBELLATA L — On creek and lake borders At Eagle, Austin, East, White, Sugarloaf, Woods, and Crooked lakes, south of Butterfield Lake in Ross Township, near Flowerfield Creek in Section 20, Prairie Ronde Township

STACHYS HYSSOPIFOLIA Michx — Sandy soil near the shores of Eagle, White, West, Sugarloaf, Austin, Stony, and Gourdneck lakes; borders of several marshes in Prairie Ronde and Texas townships Sandy fields in Section 17, Oshtemo Township, and Section 32, Portage Township

MONARDA PUNCTATA L var VILLICAULIS Pennell — Texas, Portage, and Oshtemo townships On the east side of the county it is found west of Stony Lake

LINARIA CANADENSIS (L) Dumont — Frequent in the west part of the county near Sugarloaf and Hampton lakes, in Section 7, Oshtemo Township, and in Section 23, Alamo Township Also west of Spring Brook in Cooper Township

GERARDIA PURPUREA L — On sandy lake shores Austin and Duck lakes.

MELAMPYRUM LINEARE Lam var LATIFOLIUM (Muhl) Beauv — Sandy soil east of Sugarloaf Lake in Section 4, Schoolcraft

Township, and in Section 35, Prairie Ronde Township Near Austin and Goose lakes

UTRICULARIA GIBBA L — Muddy borders of lakes and creeks Of the thirteen locations known to us in the county all are in the restricted area with the exception of two, which are at Stony Lake, Ross Township, and in Le Fevre Bog in Section 8, Climax Township

UTRICULARIA PURPUREA Walt — The only station known to us is at White Lake, Kalamazoo Township, where it grows in 12 to 18 inches of water

UTRICULARIA RESUPINATA B D Greene — In shallow water on the borders of Austin, Pickerel, White, Eagle, and Pretty lakes Change of water level affects its abundance

UTRICULARIA CORNUTA Michx — On the marshy border of Mud Lake, north of Sugarloaf Lake, near the east shore of Pawpaw Lake Scarce at both locations We have collected this species at Pleasant Lake, Barry County

BIDENS DISCOIDEA (T & G) Britt — In a swampy thicket one mile northeast of Vicksburg in the northwest quarter of Section 8, Brady Township

Kalamazoo County has sixteen townships, with a total land and water area of 575 square miles The frequency of the 54 Atlantic Coastal Plain species listed is as follows in the various townships Portage, 38, Texas, 32, Schoolcraft, 20, Oshtemo, 15, Pavilion, 13, Prairie Ronde, 10, Brady, 9, Ross, 9, Kalamazoo, 9, of which eight are near White Lake, Climax, 4, Alamo, 3, Cooper, 2, Richland, 2, Comstock, 1, Charleston, 0, and Wakeshma, 0

SCHOOLCRAFT, MICHIGAN

LICHENS IN AND NEAR THE OLYMPIC NATIONAL PARK, WASHINGTON *

JOYCE HEDRICK

THE specimens upon which this report is based were collected by A H Smith, of the University of Michigan, in September and October of 1935 and during April, May, and June of 1939 They number over 600 The present paper consists of a list of 146 species and subspecies based on 465 specimens, which have been deposited in the Herbarium of the University of Michigan

The collecting was done in and near the Olympic National Park, Washington The main region covered extends from Port Angeles to Lake Crescent, along the southern shore of Lake Crescent, Storm King Mountain, then south to Deer Lake and east to Boulder Peak and Olympic Hot Springs, along the Elwha River and up the trail along Hurricane Ridge to Steeple Peak and Obstruction Point Other specimens were found farther west in the state, along the Pyscht River, at Cape Flattery, around Lake Ozette, along the Hoh River, and south to the Clearwater River

Incidental collections were made at elevations ranging from sea level to 2,500 feet Special care was taken to collect on the rock exposures in the higher elevations Intensive collecting was done on Storm King Mountain, up to 4,500 feet, and on Boulder Peak at an elevation of 5,000 to 7,000 feet Elevations less than 2,500 feet are not given in the list

Lists and descriptions of lichens from Washington have been published by Tuckerman (1866, 1883, 1884), Müller (1889), Merrill (1908, 1909, 1910, 1911, 1913, 1914), Fink (1919), and Magnusson (1932) More extensive work has been done by Herre (1917) in a paper based on the lichens of Whatcom County and by Howard (1937) in a report of her collections throughout the state Howard lists 283 species and subspecies and observes that no really exhaustive collecting was done in any one region

* Papers from the Herbarium of the University of Michigan

So far as I have been able to ascertain, the 18 species and 4 subspecies marked with an asterisk (*) in this account have not been previously reported from the state of Washington

List of Species

PYRENULACEAE

PYRENULA LAEVIGATA (Pers) Ach — On alder, Cape Flattery, 1890a, 1895

PYRENULA NITIDA (Weig) Ach -- On alder, Cape Flattery, 13151

CALICIACEAE

*CALICIUM CURTISII Tuck — On conifer trees and pitch of fir, Deer Lake Trail, 14314, 14316

*CALICIUM TRACHELINUM Ach — On decorticate trees and logs, Hurricane Ridge, 2364, 2371, Lake Angeles, 14647

CONIOCYBE FURFURACEA (L) Ach — On rocks at base of tree, Lake Crescent, 2281, 2284, 11136

CYPHELIACEAE

CYPHELIUM INQUINANS (J E Smith) Trevis — On old stumps, Storm King Mountain, 2275

*CYPHELIUM VENTRICULOSUM (Müll Arg) Zahlbr — On old stump, Lake Crescent, 2253

SPHAEROPHORACEAE

SPHAEROPHORUS GLOBOSUS (Huds) Vainio — On old logs and fallen trees, Olympic Hot Springs, 1965, 1996, 2003, 2121, Lake Crescent, 1833, 1956, 2263, 2282, Elwha River, 2304; Boulder Lake Trail at 4,500 ft , 13816

ARTHONIACEAE

ARTHONIA EXCEDENS Nyl — On alder, Cape Flattery, 1906

ARTHONIA RADIATA (Pers) Ach — On bark, Pyscht River, 1919a.

GRAPHIDACEAE

OPEGRAPHA VARIA Pers — On twigs of tree, Cape Flattery, 13781, 13786

GRAPHIS SCRIPTA (L.) Ach.—On alder, Cape Flattery, 1906a, Pyscht River, 1914, Olympic Hot Springs, 2149, Hoh River, 13367, 13369, 13373.

GRAPHIS SCRIPTA var. SERPENTINA (Ach.) Meyer.—On alder, Pyscht River, 1916, Hoh River, 13374.

THELOTREMACEAE

THELOTREMA LEPADINUM Ach.—On alder, Olympic Hot Springs, 1993.

DIPLOSCHISTACEAE

DIPLOSCHISTES SCRUPOSUS (Schreb.) Norm.—On rocks, Storm King Mountain at 3,500 ft., 2231, 2255.

COLLEMACEAE

LEPTOGIUM PALMATUM (Huds.) Mont.—On moss, Hoh River, 13361.

PANNARIACEAE

PARMELIELLA LEPIDIOTA (Sommerf.) Vainio.—On bark, Olympic Hot Springs, 1979, Deer Lake Trail, 13413.

*PARMELIELLA CORALLINOIDES (Hoffm.) Zahlbr.—At base of tree, Lake Crescent, 13836.

PANNARIA GRANATINA (Sommerf.) T. Fries.—On rock, talus slope, Olympic Hot Springs, 2102, Storm King Mountain at 4,000 ft., 2212.

PANNARIA PEZIZOIDES (Weberi) Trevis.—On soil, Boulder Peak at 6,000 ft., 2741, on moss, Deer Lake Trail at 3,500 ft., 14329.

*PANNARIA LEUCOSTICTA Tuck.—On rocks, Olympic Hot Springs, 1991, 1997, 2154.

PSOROMA HYPNORUM (Vahl.) S. F. Gray.—Over moss and débris, Olympic Hot Springs at 3,500-4,000 ft., 1968, 2120, Steeple Peak at 5,000 ft., 2323.

STICTACEAE

LOBARIA OREGANA (Tuck.) Müll. Arg.—Over rocks, Deer Lake Trail, 13342.

LOBARIA PULMONARIA (L.) Hoffm.—On trees, Olympic Hot Springs, 1995, 20001, 2004; Hoh River, 13235.

STICTA ANTHRASPIS Ach.—On alder, Cape Flattery, 13127.

PELTIGERACEAE

SOLORINA CROCEA (L.) Ach.—On soil and moss, Boulder Peak at 6,000 ft., 2918.

NEPHROMA RESUPINATUM (L.) Ach.—On alder, Olympic Hot Springs, 2109; Cape Flattery, 13125, 13126.

PELTIGERA APHTHOSA (L.) Willd.—On old logs, débris, soil, and humus, Lake Crescent, 1830, 2244, 2245, 2247; Olympic Hot Springs, 1980; Boulder Peak at 6,000 ft., 2904; Deer Lake Trail, 13346.

PELTIGERA VENOSA (L.) Baumg.—On soil, Lake Crescent, 2273.

PELTIGERA POLYDACTYLA (Neck.) Hoffm.—Over old tree and log, Olympic Hot Springs, 2122; Clearwater River, 13272; Kalaloch, 13324.

PELTIGERA SCUTATA (Dicks.) Duby.—On alder, Cape Flattery, 1894.

PELTIGERA CANINA (L.) Willd.—On débris, soil, old logs, and moss, Olympic Hot Springs, 1984; Steeple Peak at 5,000 ft., 2317, 2318, 2324; Kalaloch, 12071, 12075; Hoh River, 13357.

PELTIGERA CANINA var. MEMBRANACEA (Ach.) Duby.—On old logs, over soil and moss, Clearwater River, 13278; Kalaloch, 13326, 13327, 13329; Lake Ozette, 13744.

LECIDEACEAE

*LECIDEA VERNALIS (L.) Ach.—On twigs, rotten wood, and over moss, Olympic Hot Springs, 1987, 2127, 2129, 2156; Steeple Peak at 5,000 ft., 2314; Boulder Peak at 6,000 ft., 2908.

LECIDEA CINNABARINA Fée.—On bark, fallen trees, and old stump, Olympic Hot Springs at 4,000 ft., 2005; Hurricane Ridge at 5,500 ft., 2360a, 2386, 2387; Cape Flattery, 13792; Boulder Lake Trail, 13819a.

LECIDEA CARNULENTA (Tuck.) Fink.—On bark, Olympic Hot Springs, 1972, 1976, 1992; on old wood, Hurricane Ridge at 5,500 ft., 2380; Crystal Ridge, 14991.

LECIDEA GRANULOSA (Hoffm.) Ach.—On old and burned wood, over soil and débris, Storm King Mountain at 3,500 ft., 2214, 2233; Steeple Peak at 5,000 ft., 2322, 2328, 2329; Hurricane Ridge at 5,500 ft., 2367, 2372, 2379, 2389; Boulder Peak at 5,500–6,000 ft., 2916, 2921.

*LECIDEA MELANCHEIMA Tuck — On old wood, Hurricane Ridge at 5,500 ft, 2383, 2390, 14863

LECIDEA FUSCESCENS Sommerf — On trees, Hurricane Ridge at 5,500 ft, 2360, 2417

LECIDEA ENTEROLEUCA Ach — On rocks, Steeple Peak at 5,300 ft, 2342, Hurricane Ridge at 6,000 ft, 2410, 2418a

LECIDEA PLATYCARPA Ach — On rocks, talus slope, Olympic Hot Springs at 3,500 ft, 1966, 1989, 1992, 2087, 2092, 2159, Hurricane Ridge at 5,500 ft, 2384a, 2392, Boulder Peak at 5,500 6,000 ft, 2730, 2739, 2861, 2888, 2891, 2896, 2902

LECIDEA LAPICIDA Ach — On rocks, talus slope, Olympic Hot Springs, 2134, Storm King Mountain at 3,500 ft, 2241, 2243a, Steeple Peak at 5,300 ft, 2341, Boulder Peak at 5,500–6,000 ft, 2721, 2722, 2731, 2736, 2856a, 2866

LECIDEA ALBOCAERULESCENS var FLAVOCAERULESCENS Schaer — On rocks and talus slope and along stream, Olympic Hot Springs, 2112, 2124, Storm King Mountain at 4,300 ft, 2267, Boulder Peak at 5,500 ft, 2860, 2863b, 2871

LECIDEA ATROBRUNNEA (Ram) Schaer — On rocks, Storm King Mountain at 3,800 ft, 2249, 2250

LECIDEA FUSCOATRA (L) Ach — On rocks, Storm King Mountain at 3,500–4,000 ft, 2221, 2232, 2237, 2252, 2257, 2265, 2279, Hurricane Ridge at 6,000 ft, 2399a, Boulder Peak at 5,500 ft, 2862, 2863a, 2875, 2882, 2894, 2904

PSORA OSTREATA Hoffm — On old wood, Olympic Hot Springs, 1994

*NESOLECHIA VITELLINARIA (Nyl) Rehm — On the thallus of *Candelariella vitellina*, Boulder Peak at 6,000 ft, 2726

MYCOBLASTUS SANGUINARIUS (L) Norm — On bark, Lake Crescent, 1951, 2280, Olympic Hot Springs, 1958, Elwha River, 2308, 2310, Boulder Peak at 5,500 ft, 2905, Kalaloch, 13011, Boulder Lake Trail, 13819a, Crystal Ridge, 14989, 14990

MYCOBLASTUS ALPINUS (E Fries) Kernst — On bark and old stumps, Olympic Hot Springs, 1969, 1971, 1983, 1986, Lake Crescent, 2240, Hurricane Ridge at 5,500 ft, 2365, 2422, 2433, Deer Lake Trail, 14313

CATILLARIA TRICOLOR (With) T Fries — On bark, Elwha River, 2306

*CATILLARIA FRANCISCANA (Tuck) Herre — On rocks, Storm King Mountain at 3,800–4,000 ft, 2270, 2277

*BACIDIA FLAVOVIRESCENS (Dicks) Anzi — On débris, Storm King Mountain at 4,000 ft, 2213

LOPADIUM PEZIZOIDEUM (Ach) Koerb — On alder, Olympic Hot Springs at 3,500 ft, 1967, 1978, 2130, 2137

*RHIZOCARPON OEDERI (Web) Koerb — On rocks, talus slope, Olympic Hot Springs, 2086

RHIZOCARPON PETRAEUM (Wulf) Mass — On rocks, Storm King Mountain at 3,500 ft, 2216, 2254

RHIZOCARPON PENICHRUM (Tuck) Merrill — On bark, Lake Crescent, 2253a, 13983, on old stump, Storm King Mountain at 3,000 ft, 2229, 2260, 2272

RHIZOCARPON LECANORINUM (Koerb) Anders — On rocks, talus slope, Olympic Hot Springs, 2098

RHIZOCARPON GEOGRAPHICUM (L) Lam & DC — On rocks, talus slope, Olympic Hot Springs, 2081, Steeple Peak at 5,300 ft, 2334, Hurricane Ridge, 2399, 2428, 2432, 2434, Boulder Peak at 5,500 ft, 2853, 2856, 2859, 2868, 2877, 2879

RHIZOCARPON OIDALEUM (Tuck) Fink — On old tree, Lake Crescent, 2276

CLADONIACEAE

PILOPHORUS CEREOLUS (Ach) T Fries — On rocks, Lake Crescent, 1837, Olympic Hot Springs at 3,500–4,000 ft, 1976, Deer Lake Trail, 13340

CLADONIA RANGIFERINA (L) Web — Among and over mossy rocks, talus slope, Olympic Hot Springs, 2085, 2111, 2118, 2131, 2151

CLADONIA SYLVATICA (L) Hoffm — Over rocks, base of talus slope, Olympic Hot Springs, 2079a

CLADONIA MACILENTA Hoffm — On old log and stump, Cape Flattery, 1892, 1896, Lake Crescent, 1952, 1954

CLADONIA BELLIDIFLORA (Ach) Schaer — On soil and old logs, talus slope, Olympic Hot Springs, 1981, 2132, Boulder Peak at 5,500 ft, 2911, 2960, Kalaloch, 13161, Hoh River, 13637

CLADONIA BELLIDIFLORA var COCCOCEPHALA (Ach) Vainio — Over and among rocks, along stream, Olympic Hot Springs, 2116, Hurricane Ridge at 5,500 ft, 2381

CLADONIA UNCIALIS (L) Hoffm — On débris, Storm King Mountain at 4,000 ft, 2215

CLADONIA FURCATA (Huds) Schrad — On soil and débris, Lake Crescent, 1832; Storm King Mountain at 3,800 ft, 11130

CLADONIA FURCATA var RACEMOSA (Hoffm) Floerke — On soil, Lake Crescent, 1831, 11131, 11132, Storm King Mountain at 3,000 ft, 2271, Hoh River, 13644

CLADONIA FURCATA var PINNATA (Floerke) Vainio – On soil, Storm King Mountain at 3,000 ft, 2223, Hoh River, 13640, near trail, Lake Crescent, 13849

*CLADONIA FURCATA var SCABRIUSCULA (Del) Vainio — On exposed soil, Lake Crescent, 1834

CLADONIA FURCATA var PALAMAEA (Ach) Nyl — On débris and over rocks, Storm King Mountain at 3,000 ft, 2227, at lake edge, Lake Crescent, 13837

CLADONIA SQUAMOSA (Scop) Hoffm — Among rocks, talus slope, Olympic Hot Springs, 2106

CLADONIA SQUAMOSA var DENTICOLLIS (Hoffm) Floerke — On soil, Boulder Peak at 5,500 ft, 2922, 2924

CLADONIA SUBSQUAMOSA (Nyl) Vainio On old logs and débris, Lake Crescent, 1953, 2256, Crescent Beach, 2976, 2981, Kalaloch, 13164, Hoh River above Jackson Guard Station, 13382, Hoh River, 13636

CLADONIA CENOTEA (Ach) Schaer — On old log, Crescent Beach, 2974

CLADONIA CARIOSA (Ach) Spreng — On soil, Steeple Peak at 5,000 ft, 2321

CLADONIA GRACILIS (L) Willd — On soil, Boulder Peak at 6,000 ft, 2907

CLADONIA GRACILIS var ECMOCYNA (Ach) Scriba — On soil, Steeple Peak at Obstruction Point Road, 2315, Hurricane Ridge at 5,500 ft, 2374, Boulder Peak at 6,000 ft, 2906, Crystal Ridge, 14985

CLADONIA GRACILIS f ANTHOCEPHALA Floerke — On soil, Steeple Peak at Obstruction Point Road, 2316, Hurricane Ridge at 5,500 ft, 2359, 2373, 2375, 2378, Boulder Peak at 5,500 ft, 2913

CLADONIA GRACILIS var DILATATA (Hoffm) Vainio — On soil, Hurricane Ridge at 5,500 ft, 2361, 2362

CLADONIA GRACILIS var CHORDALIS (Floerke) Schaer — On soil and among rocks, base of talus slope, Olympic Hot Springs, 2079, 2080, Bogachiel Ridge at 5,500 ft, 2719, Boulder Peak at 6,000 ft, 2915

*CLADONIA GRACILIS var ASPERA Floerke — On soil, Boulder Peak at 6,000 ft, 2923

*CLADONIA GRACILIS var ELONGATA (Jacq) E Fries — Over mossy rocks, talus slope, Olympic Hot Springs, 2117

CLADONIA GRACILESCENS (Floerke) Vainio — On cedar stump, Olympic Hot Springs, 1998

CLADONIA PYXIDATA (L) Hoffm — On soil, Hurricane Ridge at 5,500 ft, 2370, Storm King Mountain, 14275

CLADONIA PYXIDATA var CHLOROPHAEA (Ach) Flot — On soil and débris, Olympic Hot Springs, 2139, Lake Crescent, 11133

CLADONIA VERTICILLATA var CERVICORNIS (Ach) Flot — On soil, talus slope, Olympic Hot Springs, 2142

CLADONIA FIMBRIATA var SIMPLEX (Weiss) Flot — On thin soil over rocks, Lake Crescent, 1835

CLADONIA FIMBRIATA var SUBULATA (L) Vainio — On soil over old logs, Hurricane Ridge at 5,500 ft, 2420

CLADONIA FIMBRIATA var CONIOCRAEA (Floerke) Vainio — On old log, Hurricane Ridge at 5,500 ft, 11134

CLADONIA FIMBRIATA var OCHROCHLORA (Floerke) Vainio — On old log and débris, Cape Flattery, 1888, talus slope, Olympic Hot Springs, 2135, 2138

*CLADONIA CYANIPES (Sommerf) Vainio — On soil over wood, Hurricane Ridge at 5,500 ft, 2368

CLADONIA CARNEOLA (Ach) Spreng — On débris, Storm King Mountain at 3,000 ft, 2228

CLADONIA CARNEOLA var PROLIFERA Flot — On rotten wood, Hurricane Ridge at 5,500 ft, 2363

STEREOCAULON PASCHALE var CONGLOMERATUM E Fries — On soil over rocks, Storm King Mountain at 3,500 ft, 2238

STEREOCAULON TOMENTOSUM E Fries — Over rocks along stream, Olympic Hot Springs, 2105, 2108, 2113, 2133, on débris, Storm King Mountain at 3,500 ft, 2262, on dry sandy soil, Hoh River bank above Jackson Guard Station, 13412

STEREOCAULON TOMENTOSUM var SIMPLEX Riddle — Over rocks, Storm King Mountain, 14273

UMBILICARIACEAE

UMBILICARIA HYPORBOREA Ach — On rocks, Hurricane Ridge at 6,000 ft, 2395, 2401, Boulder Peak at 6,000 ft, 2912

UMBILICARIA PROBOSCIDEA (L) Schrad — On rocks, Hurricane Ridge at 6,000 ft, 2397a, Boulder Peak at 6,000 ft, 2867, 2887

ACAROSPORACEAE

*BIATORELLA RESINAE (E Fries) T Fries — On wounds of conifer tree, Deer Lake Trail, 14315, 14319, on débris over rocks, Crystal Ridge, 14993

PERTUSARIACEAE

PERTUSARIA MULTIPUNCTA (Turn) Nyl — On alder, Olympic Hot Springs, 2125

*PERTUSARIA VELATA (Turn) Nyl – On fallen hemlock, Lake Ozette, 13433

LECANORACEAE

LECANORA GIBBOSA (Ach) Nyl — On rocks, Hurricane Ridge at 5,500 ft, 2427, Boulder Peak at 6,000 ft, 2876

LECANORA LAEVATA (Ach) Nyl — On rocks along stream, Olympic Hot Springs, 2147

LECANORA CINEREA (L) Röhling — On rocks, Storm King Mountain at 3,000–3,800 ft, 2218, 2243, 2282, Steeple Peak at 5,300 ft, 2335, 2337, 2338, 2340, Hurricane Ridge at 6,000 ft, 2410a, 2418, 2419, 2434a, Boulder Peak at 5,500 ft, 2874

*LECANORA GLAUCOMELA Tuck — On alder, Olympic Hot Springs, 2146, Deer Lake, 13414, 14328

LECANORA ALPINA Sommerf — On rocks, Storm King Mountain at 3,500 ft, 2230

LECANORA SUBFUSCA (L) Ach — On alder, Pyscht River, 1913, 1920, Olympic Hot Springs, 2158

LECANORA SUBFUSCA var ARGENTATA Ach — On alder, Hoh River, 13360, 13362a, 13370

LECANORA PACIFICA Tuck — On trees, Lake Crescent, 1949, 13833, 13854, 14385, Cape Flattery, 13139

LECANORA POLYTROPA (Ehrh) Rabenh — On rocks, talus slope, Olympic Hot Springs, 2090, Storm King Mountain at 4,000 ft, 2242, Steeple Peak at 5,000 ft, 2312, 2313, Hurricane Ridge at 6,000 ft, 2393, 2404, 2406, 2414, Boulder Peak at 5,500 ft, 2738, 2886

LECANORA POLYTROPA var ALPIGENA (Ach) Rabenh — On rocks, Steeple Peak at 5,000 ft, 2327, Hurricane Ridge at 6,000 ft, 2408, Boulder Peak at 5,500 ft, 2890

Lecanora polytropa var illusoria (Ach) Leight — On rocks, Hurricane Ridge at 5,500 ft , 2369, 2384

Lecanora rupicola (L) Zahlbr — On rocks, Hurricane Ridge at 6,000 ft , 2396, 2405, 2408, 2409, 2415, Boulder Peak at 6,000 ft , 2733

Lecanora gelida (L) Ach — On rocks, Lake Crescent, 1836, Storm King Mountain at 3,500 3,800 ft , 2251, 14994a, Boulder Peak at 5,500 ft , 2885

Ochrolechia tartarea (L) Mass — On old log and trees, Lake Crescent, 1955, 2246, Elwha River, 2307, 2309, Kalaloch, 13011a, Boulder Lake Trail at 4,500–6,600 ft , 13805, 13819, Crystal Ridge, 14988

Ochrolechia pallescens (L) Mass — On trees, Pyscht River, 1909, 1911, Olympic Hot Springs, 2136, 2140, 2157, Cape Flattery, 13146, Hoh River, 13362, 13365, 13367

Ochrolechia pallescens var rosella Tuck — On trees, Olympic Hot Springs, at 2,500 4,000 ft , 1964, 1973, 1985, 2002

Ochrolechia upsaliensis (L) Mass — On débris, Boulder Peak at 6,000 ft , 2910, Storm King Mountain at 4,000 ft , 11137

Icmadophila ericetorum (L) Zahlbr — On old wood, Lake Crescent, 1838, 2069, 13844, Olympic Hot Springs, 1962, Oil City, 13103

Candelariella vitellina (Ehrh) Müll Arg — On rocks, Storm King Mountain at 3,500 3,800 ft , 2219, 2236, 14994

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Parmelia physodes var enteromorpha Tuck — On trees, Cape Flattery, 1904, Olympic Hot Springs at 2,500-3,000 ft , 1963, Boulder Lake Trail at 6,500 ft , 13804

Parmelia physodes var vittata Ach — On trees, Olympic Hot Springs, 13802

Parmelia pertusa (Schrank) Schaer — On trees, Pyscht River, 1908, 1912, Olympic Hot Springs, 2107, Hurricane Ridge at 5,500 ft , 2416

Parmelia perlata (L) Ach — On trees, Cape Flattery, 1891, 1893, Boulder Peak at 5,500 ft , 2919

Parmelia saxatilis (L) Ach — On rocks, Boulder Peak at 5,500 ft , 2872

Parmelia sulcata Tayl — On rocks, Olympic Hot Springs, 2156

*PARMELIA COLPODES (Ach) Nyl — On trees, Olympic Hot Springs, 1974, 1975, Hurricane Ridge at 5,500 ft, 2376, 2385, 2391, Crystal Ridge, 14984

CETRARIA GLAUCA (L) Ach — On trees, Boulder Lake Trail at 6,500 ft, 13803, 13804

CETRARIA PLATYPHYLLA Tuck — On trees, Crystal Ridge, 14981

CETRARIA ISLANDICA (L) Ach — On trees, Hurricane Ridge at 5,500 ft, 2358, Crystal Ridge, 14980

*CETRARIA TRISTIS (Web) E Fries — On rocks, Hurricane Ridge at 6,000 ft, 2394, 2397, 2400, 2402

USNEACEAE

*ALECTORIA DIVERGENS (Ach) Nyl — On rocks, Hurricane Ridge at 6,000 ft, 2401a

ALECTORIA IMPLEXA (Hoffm) Rohling — On trees, Hurricane Ridge at 5,500 ft, 2377, 2421

ALECTORIA SARMENTOSA Ach — On trees, Olympic Hot Springs at 2,500–4,000 ft, 1970, Elwha River, 2305, Hurricane Ridge at 5,500 ft, 2377a, 2421a, Kalaloch, 13152, Crystal Ridge, 14982, 14983

RAMALINA FARINACEA (L) Ach — On trees, Cape Flattery, 1889a, 1902, 13130, 13132, 13148

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USNEA PLICATA (L) Web — On trees, Cape Flattery, 1897

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BUELLIA PAPILLATA (Sommerf) Tuck — On soil, Steeple Peak at 5,500 ft, 2325

RINODINA HALLII Tuck — On alder, Cape Flattery, 1905, 13138, 13141

UNIVERSITY OF MICHIGAN

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NEW AND UNUSUAL AGARICS FROM MICHIGAN III *

ALEXANDER H SMITH

DURING late August and early September, 1940, heavy rainfall and moderately cool weather brought out a very luxuriant agaric flora in the vicinity of Ann Arbor Fleshy forms were particularly abundant The number of species of Tricholoma which appeared was greater than that seen during any previous season I had spent in Michigan Species of Entoloma were also plentiful *Entoloma prunuloides* was found in several localities in such quantity that one could have collected a truck load of it had he so desired *Tricholoma resplendens*, *T sejunctum*, and *T transmutans* occurred everywhere throughout one large oak woods and were common in several other localities The fleshier lignicolous species were no more frequent than usual

Critical studies of nine species of Tricholoma, two of Lepiota, and one of Armillaria are included in this account The collections cited have been deposited in the University of Michigan Herbarium All color terms within quotation marks are taken from R Ridgway, *Color Standards and Color Nomenclature*, Washington, D C , 1912

List of Species

ARMILLARIA AMBROSII Bres — Pileus 1 3 5 cm broad, convex or with a slight umbo, sometimes obtusely conic, surface dry and densely covered by small granulose warts or scales or by a more or less even powdery covering (when the scales have been worn down or broken), surface even or slightly radially rugose, color white to whitish, becoming "cartridge-buff" at times, margin beautifully appendiculate with submembranous patches of the broken veil, the outer side of these patches bearing small powdery scales similar to those on the pileus, flesh white, thick on the disc,

* Papers from the Herbarium of the University of Michigan

thin toward the margin, firm, dry, lamellae close (35–39 reach the stipe), broad (3 mm ±), slightly but sharply adnexed, white, edges crenulate, stipe 5–7 cm long, 2 5–3 mm thick, equal above a base enlarged by adhering white mycelium and débris, increasingly granulose-scaly up to the apical submembranous annulus, white and silky above, glabrescent and merely faintly powdery in age, stuffed, concolorous with the pileus at all stages, annulus with powdery scales on under side, upper surface silky, spores 4–5 × 3 μ, hyaline, ellipsoid, smooth, amyloid, basidia four-spored, pleurocystidia and cheilocystidia not differentiated, gill trama homogeneous, nearly hyaline in iodine (basidia yellow), pileus trama homogeneous beneath a surface layer of globose thin-walled hyaline cells 20–35 μ thick, all parts yellowish in iodine or remaining nearly hyaline

Gregarious under pine, Ogemaw Forest, Midland, Sept 25, 1938 (11091)

I have found this species but once, and was then inclined to regard it as an albino form of *Armillaria rugoso-reticulata* If, however, one adheres to the principle of using color to separate species in this group, Bresadola's species should also be recognized On such a basis it is very close to the European *Cystoderma charcharias* or *Lepiota charcharias*, depending upon which name is preferred, but differs in being white Both have amyloid spores, a character also possessed by the specimens of *A rugoso-reticulata* in the University of Michigan Herbarium

Lepiota cystidiosa, sp nov (Pls I–II) — Pileus (2) 3–9 cm latus, conicus vel convexus, demum umbonatus vel planus, siccus, pulveraceo-squamulosus vel granulosus, pallidus, demum alutaceus, lamellae confertae, latae, albidae demum alutaceae, stipes 4–8 cm longus, 3–7 cm crassus, aequalis vel subbulbosus, dense pulverulentus, sporae 4–4 5 × 2 5 μ, pleurocystidia et cheilocystidia similia, 25–42 × 12–7 μ, distinctissima Specimen typicum legit A H Smith n 15268, prope Ann Arbor, Mich , Sept 9, 1940, in Herb Univ Mich conservatum

Pileus (2) 3–9 cm broad, obtusely conic to convex when young, becoming broadly convex to plane in age or occasionally remaining umbonate, the margin sometimes undulated or wavy, surface dry, at first covered by conic powdery warts from the disc to the margin, soon becoming merely granulose to pulverulent as the

warts break up, not truly scaly, the warts or powdery débris "pinkish buff" to "pale pinkish buff," the white flesh showing until late maturity, eventually somewhat brownish buff over all or "wood-brown," occasionally nearly glabrous in age, margin at first delicately appendiculate with soft powdery masses of veil tissue which soon fall off, flesh soft and dry, white, slowly changing to sordid buff (not reddish) when cut or bruised, odor sharp but faint and easily overlooked, taste bitterish, lamellae free but almost touching the stipe, broad (8–12 mm), broadest at the stipe and tapering evenly to the margin, very close but distinct, 2 3 tiers of short individuals, pure white at first, soon cream-color and becoming "wood-brown" (dull brown) like the pileus, often stained dark sordid brown and in decaying pilei occasionally dark purple-brown overall, stipe 4–8 cm long, 3–7 mm thick, equal or the base slightly bulbous, hollow, rather fragile, context silky, surface over lower three fourths covered by dense powdery masses of veil tissue (up to the powdery zone left by the broken veil), silky over the upper portion, annulus seldom formed or soon evanescent, veil remnants concolorous with the powdery covering of the pileus, whitish beneath but in age generally "wood-brown" like the cap, spores 4–4 5 × 2 5 μ, ellipsoid or the base slightly truncate, hyaline, smooth, pale yellowish to tawny-brown in iodine, basidia four-spored, pleurocystidia abundant, usually fusoid with acute apices or ventricose-subcapitate, the head 3–5 μ in diameter, in water mounts usually with a slight incrustation and a highly refractive globular content (probably of oil droplets), 25–42 × 7–12 μ (or 20–30 × 8–12 μ in saccate individuals), gill trama homogeneous, nearly hyaline in iodine, pileus trama homogeneous beneath a surface covering of inflated, thin-walled cells 15–40 μ thick, which are tinged pale cinnamon in iodine-chloralhydrate solution

Scattered on muck soil under a dense growth of Impatiens, Ann Arbor, Sept 9, 1940 (15268) My first collection of this species was made on Sept 23, 1931, at Cascade Glen, Ann Arbor Since that time until 1940 I had searched in vain for enough material to study critically Collection 15268 consisted of two market baskets full of fruiting bodies The pleurocystidia were a constant character in No 15268, as well as in No 15217, from

Milford, Aug 30, and in No 15263, from Cascade Glen, Ann Arbor, Sept 6, 1940

I was at first inclined to place my collections in *Lepiota Hetieri*, but Kühner (1), who has published an account of that species, does not mention any pleurocystidia in his rather detailed description of the microscopic characters In addition to this, there appears to be a difference in habitat, size, and color change My specimens were in perfect condition, but did not show any tendency to stain red in any part until decay had set in, at which time the gills became spotted by very dark sordid purplish spots and finally turned purplish overall Smith and Hesler (4) collected a fungus in the Great Smoky Mountains National Park which did show the color change to red when bruised and which has scattered pleurocystidia We placed these specimens in *L rufescens* because of their resemblance to Lange's (2) figures and because his description covered our specimens very well Lange described the cystidia as being on the gill edge Because pleurocystidia were rare in our specimens it appeared to me that Lange had probably overlooked them It must be remembered that he was under the impression that pleurocystidia were not present in any of the Lepiotae, and therefore his data on this point cannot be given much weight Kühner (1) has included several species with distinctive pleurocystidia in his treatment of the genus for France Both Kuhner and Lange compare *L rufescens* to *L rosea* Rea and apparently regard *L rufescens* as varying considerably toward the rose or red color This is not true for *L cystidiosa* If the *L rufescens* of Lange does have pleurocystidia, then it and *L Hetieri* are very likely distinct, but *L cystidiosa* would still be distinct from either Consequently it is described here as a new species

Lepiota roseotincta, sp nov — Pileus 2 5–3 cm latus, obtusus vel subconvexus, siccus, roseo-fibrillosus, tactu aurantius et demum fuscus, lamellae confertae, latae, albidae vel incarnato-tinctae, non maculosae; stipes 3–4 cm longus, 4–5 mm crassus, subclavatus vel anguste fusiformis, cavus, albidus, tactu aurantius et demum fuscus, sporae 7–10 × 4–5 μ Specimen typicum legit A H Smith n 15327, prope Ann Arbor, Mich , Sept 13, 1940, in Herb Univ Mich conservatum

Pileus 2 5–3 cm broad, convex or with a flattened disc, surface

dry, appressed-fibrillose, disc "deep Corinthian red," the marginal area streaked with "Corinthian pink" fibrils (deep to light pinkish-vinaceous), the ground color white, the fibrils arranged in appressed fascicles near the margin, not scaly, surface quickly staining bright orange when bruised, portions soon becoming blackish, flesh thin, white, soft, unchanging, odor none, taste mild, lamellae close to crowded, moderately broad, free, reaching the stipe (but tending to become remote in age), 1–2 tiers of short individuals, not staining when bruised, white or evenly flushed pink toward the margin of the pileus, edges even, stipe 3–4 cm long, 4–5 mm thick at the apex, slightly clavate-bulbous but tapered to a long point below (almost fusiform in one), hollow, fragile, white within, surface white and delicately white-tomentose above and below the median white membranous annulus, annulus with scattered, pink fibrils on the under side, surface fibrils both above and below the annulus quickly staining reddish orange when bruised, the stains eventually becoming sordid brown, spores narrowly subovoid, with an oblique apiculus and a somewhat pointed apex, 7–10 × 4 5 μ, smooth, turning rusty brown in iodine, basidia four-spored, cheilocystidia abundant, forming a sterile band along the edge of the gill, hyaline (in water or KOH), smooth, fusoid-ventricose with obtuse apices, 36 48 × 9–14 μ, pleurocystidia not differentiated, gill trama homogeneous, hyaline to pale yellowish in iodine, pileus trama homogeneous beneath an irregular layer of more or less radially arranged hyphae having sordid reddish contents in KOH and measuring 8-15 μ thick, the tissue beneath composed of hyaline hyphae of about the same diameter or slightly larger

Gregarious on débris at the base of a basswood tree, Ann Arbor, Sept 13, 1940 (15327) Known only from the type collection

In many respects this species resembles *L rubrotincta* Pk It differs markedly from that species, however, in the very pronounced and rapid color change As in *L flammeotincta*, this change is confined to the surface fibrils of the pileus and stipe, but it is unlike that species in that the bruised portions darken in a short time and never regain their original color The lamellae are merely flushed with pink and do not stain or exhibit any distinctive color change *L roseotincta* reminds one a lot of *Agaricus diminutivus* in its colors and the fibrillose surface cover-

ing of the pileus. Among the European species *L sublittoralis* Kühner is apparently close, but lacks the striking color change

TRICHOLOMA AROMATICUM Murr (Pl III) — Pileus 3–7 cm broad, obtuse with an inrolled margin when young, plane or umbonate in age, umbo obtuse, surface dry and unpolished, appearing glabrous to the naked eye and matted-fibrillose under a hand lens (10 ×), color evenly "tilleul-buff" (pallid) or slightly darker (color not well matched in R), sometimes the margin "tilleul-buff" and the disc darker grayish buff, surface occasionally pitted or with brownish glabrous spots, flesh thick, firm, brittle, whitish, unchanging, odor and taste both strongly farinaceous, lamellae crowded and narrow (5 7 mm at the base, which is the broadest point), rather sharply adnexed, 3 4 tiers of short individuals, color evenly "cartridge-buff" (pale sordid yellowish buff at maturity), near "tilleul-buff" when young but slightly paler than the pileus, edges slightly crenulate at times and even (not eroded), stipe 4–8 cm long, 9–13 mm thick, equal or a bit enlarged at the base, solid but becoming hollow, firm whitish and coated with appressed fibrils up to the almost cottony-pruinose apex, somewhat glabrescent where handled, veil not present, spores 4–5 5 × 2 5 3 μ, ellipsoid, smooth, hyaline, not amyloid, gill trama homogeneous, of narrow parallel hyphae, yellowish in iodine, pileus trama homogeneous, surface hyphae slightly narrower than the rest, all parts yellowish in iodine

Gregarious under oak and aspen, La Badie Lake, near New Hudson, Oakland Co, Sept 23, 1940 (15440)

The very small spores are the most outstanding feature of this species which can be clearly set forth in a description, but the fungus has a very striking appearance in spite of its pale colors The very pale buff cap and yellowish gills both have a glaucous sheen not soon forgotten

Its relationships are difficult to establish In some respects the species resembles *T sulphureum*, but the small spores and farinaceous odor are not in line with the members of that group The appearance of the pileus reminds one of *T acerbum* or *T impolitum*, but it has more of a sheen than either *T Georgii* has the small spores, according to Ricken (3), but is smooth and glabrous *T albellum* sensu Rea is apparently very close Rea describes the spores as 5–6 × 3 μ My specimens were not scaly

in any sense of the word. The very thin appressed-cottony covering over the entire stipe is an outstanding feature not mentioned in descriptions of European species. Toward the apex of the stipe this layer becomes thinner and frequently breaks up, giving the impression of a soft pruinose coating.

The specimens of No. 15440 have only a slight pungent odor in the dried condition, and no odor is now present in the type. It thus appears that in this instance the choice of the specific name was most unfortunate. I did not find the spores of the type measuring more than 5.5 μ long, 4.5 $\times$ 2.5 was the usual size in my collection.

Tricholoma cuneifolium (Fr.) Gillet.—Pileus (1) 2.5 5 cm. broad, obtusely conic when young, soon convex or with an obtuse conic umbo, sometimes broadly campanulate, margin inrolled at first, surface moist and hygrophanous, evenly "fuscous" (dark to pale cinereous), the disc often remaining darker, atomate when faded, not striate at any stage, surface often having a hoary sheen when moist, flesh thick under the disc (3) 6–8 mm., tapered abruptly toward the margin, very fragile and brittle, pale grayish, becoming pallid, unchanging, odor and taste farinaceous, lamellae close (45–52 reach the stipe), 2–3 tiers of short individuals, broad and decidedly ventricose at maturity (up to 1 cm. broad), adnexed, whitish to pale gray, edges even or eroded, stipe 3–8 cm. long, 3.8 mm. thick, equal or narrowed at the base, solid, white both inside and out, glabrous, unchanging when cut or bruised, fleshy and very brittle, spores 5–6 $\times$ 3 μ, narrowly ellipsoid, smooth, not amyloid, basidia four-spored, cheilocystidia and pleurocystidia not differentiated, gill trama subparallel, yellowish to hyaline in iodine, pileus trama composed of a palisade of more or less upright pear-shaped cells 32–60 $\times$ 9–20 μ and with dull fuscous brown walls when revived in KOH, tramal body of hyaline hyphae which turned yellowish in iodine.

Single to gregarious on rich humus, 1940. Ann Arbor, Sept. 6 (15261), Sept. 11 (15549), Sept. 13 (15351), Sharron Hollow, Sept. 14 (15369), Ann Arbor, Sept. 16 (15416), La Badie Lake, New Hudson, Oakland Co., Sept. 23 (15445) and Sept. 24 (15459).

Most of the collections consisted of only one or two small

fruiting bodies, but all were saved because of the interesting microscopic characters The species was widely distributed about Ann Arbor during the season of 1940, but was certainly not abundant I had almost despaired of finding sufficient material for a critical study It has a superficial resemblance to *Collybia hymenocephala* in color and in the anatomy of the pileus The amyloid reaction of the spores of *C hymenocephala* at once distinguishes dried material, and the stature readily separates fresh specimens My collections have been compared with specimens of *T cuneifolium* sent by M Josserand, Lyon, France, and appear to be the same Large fruiting bodies dry a darker gray than the specimens from France, which were smaller than most of mine My smallest specimens, however, dried paler than the larger ones and are similar in color to those from Josserand The farinaceous odor and taste separate large specimens from *T atrocinereum*

TRICHOLOMA FALLAX (Pk) Sacc — Pileus (0 5) 1–3 cm broad, very broadly convex to obtusely umbonate and with an incurved margin when young, expanding to plane and frequently developing a recurved margin, the umbo usually disappearing, glabrous, moist, lubricous, and soft, "ochraceous orange" to "ochraceous tawny" when moist, fading to "light orange-yellow" and appearing somewhat canescent when faded, hygrophanous to subhygrophanous, glabrous, no veil remnants seen, flesh moderately thick under the disc and tapering abruptly toward the margin, soft, near "old gold" when moist, pale yellowish when faded (often concolorous with the surface when moist), odor none, taste mild, lamellae crowded, 24–27 reach the stipe, 3 tiers of short individuals, narrow to moderately broad (2–2 5 mm), broadest at the base and usually sharply adnexed, evenly "light orange-yellow" when young but developing a whitish pruinose sheen (probably from the spores), edges even, stipe 2–3 5 cm long, 3–4 mm thick, usually enlarged toward the apex, base inconspicuously fibrillose, coated with appressed yellowish fibrils overall but somewhat glabrescent in age, concolorous with the lamellae above, darker sordid yellowish below, solid but developing a tubule; spores 3–4 × 2 5 μ, hyaline, ellipsoid, smooth, not amyloid, basidia four-spored, 18–20 × 5–6 μ, cheilocystidia and pleurocystidia not differentiated, gill trama homogeneous, cells

with yellow contents in water mounts of fresh material, yellowish in iodine, pileus trama homogeneous beneath a palisade of clavate to pear-shaped cells 18–25 × 8–10 μ, which have thin walls and bright yellow contents, the hyphae of the tramal body also with yellow contents, all parts yellowish in iodine

In arcs on humus under oak, Milford, August 30, 1940 (15214) The description was drawn from this collection I found the fungus twice in Oakland County during August, 1937, and have collected it under conifers in Nova Scotia, Ontario, northern Michigan, Washington, Oregon, and California Kauffman collected it in New York

Through the kindness of Dr H D House, New York state botanist, I have been able to study the microscopic characters of Peck's type The pileus is corticated by a palisade of cells as described above, and the other characters also check with those given in the description above Kauffman left three collections identified as *T fallax* two from the Adirondacks and one from Colorado In the collection dated September 7, 1914, from the Adirondacks, the pileus is perfectly homogeneous, in the other from this locality, dated September 9, 1914, the pilei are corticated The habitat of the second collection is not recorded, that of the first is given as "under spruce and balsam" The third collection, made in 1920, consists of fruiting bodies with homogeneous pilei It is evident from Kauffman's New York material that both species look just about alike, and very likely they grow in the same habitats Habitat must be ruled out as a distinguishing character here because I have found typical *T fallax* in forests of both types

The discovery that *T fallax* belongs in the subgenus Dermoloma and that a second species exists which has the same appearance brings up the problem of a name for the second one and raises the question whether *T fallax* occurs in Europe Lange has described two species of this general type, but has not classified either one in Dermoloma Consequently the validity of his use of the name *T fallax* must now be checked before it can be accepted A study of the dried specimens would quickly settle this question The name to be used for the species with the homogeneous pileus remains a problem and involves the names *T cerinum*, *T. pseudoflammula*, and *T chrysenterum*

Murrill changed the specific name of Peck's species and made the combination *Melanoleuca naucoria* because of the existence of *Agaricus fallax* Lasch, published before Peck's name Both applied to species of Tricholoma Lasch's species, however, was referred to *T. ionides* by Fries, and the combination *T fallax* (Lasch) was apparently not published Saccardo published the combination *T fallax* (Pk), thus validating Peck's name in the genus Tricholoma

Tricholoma huronense, sp nov (Pls IV–V) — Pileus 6–9 (12) cm latus, obtusus, demum subumbonatus vel planus, siccus, fibrillosus demum cinereo-squamosus, caro albida, lamellae confertae, angustae demum sinuatae, sordide albidae, stipes 4–8 cm longus, 1–2 cm crassus, clavatus, solidus, albidus, deorsum cinereo-squamulosus, sursum albido-fibrillosus et rubro-guttulatus, sporae 7–9 × 5–6 μ Specimen typicum legit A H Smith n 15303, prope Ann Arbor, Mich , Sept 11, 1940, in Herb Univ Mich conservatum

Pileus 6–9 (12) cm broad, gibbous when young or evenly obtusely conic with an incurved margin, becoming convex and finally plane or with a low obtuse umbo, surface dry and fibrillose, "drab-gray" to "pale smoke-gray" when young (pale to moderately dark cinereous), the fibrillose gray cuticle soon becoming broken up into appressed drab spotlike scales around the disc, the white flesh showing through along the margin, margin at maturity or in age often appearing white streaked with gray fibrils, or with appressed-fibrillose patches, the margin slightly fringed and somewhat cottony but no cortina visible on buttons as small as 3–6 mm , often beaded with drops of a clear pink fluid or streaked pinkish along the margin in either young or old pilei, flesh thick and white, not changing color when cut or bruised, odor and taste both distinctly farinaceous, lamellae close to crowded (96–115 reach the stipe), adnexed, rather narrow, equal (4–8 mm), 2–3 tiers of short individuals, dull white (more cream-color than the flesh), edges slightly eroded, not staining when bruised or broken and not discoloring appreciably in drying, stipe 4–8 cm long, 1–2 cm thick at the apex, solid, clavate and 2–4 cm thick at the base, fleshy, white within, surface whitish but covered over the lower portion by appressed-fibrillose scales similar to those on the pileus, scales very pale when young but

darkening in age, silky toward the apex, often beaded with hyaline or pinkish drops of fluid or with pinkish streaks, base sometimes stained ochre-yellow, but no such color change evident when cut or bruised, spores smooth, ellipsoid, 7–9 × 5–6 μ, not amyloid, basidia four-spored, cheilocystidia 28 39 × 6–12 μ, saccate to somewhat fusoid-ventricose, when revived in KOH slightly yellowish as seen in mass on the gill edge, gill trama and pileus trama both yellowish in iodine and homogeneous

Gregarious to caespitose in arcs in oak woods, Ann Arbor, Sept 11, 1940 (15303)

A truck load of this species could have been collected in one locality on September 11 It was found in smaller amounts in many other local areas during the season of 1940, and the reddish drops of liquid were always present The yellowish stains at the base of the stipe, however, were not constant The strong farinaceous odor and taste, pale gray color, scaly cap, rather broad spores, and red drops distinguish it from all other species

No cortina was observed on any of the numerous young pilei The scales on the stipe are apparently formed by the surface fibrils becoming aggregated into patches The fibrillose layer covering the surface of the stipe is of a very loose texture The scales darken in age in much the same manner as those on the stipes of fruiting bodies of *Hygrophorus tephroleucus* Specimens in which this color change does not take place, and in which the color of the pileus has faded, are almost indistinguishable from *T venenata* The gills of the latter, however, become brownish in age *T huronense* is most closely related to the species in the *T terreum* group

Tricholoma luteomaculosum, sp nov. (Pl VI) — Pileus 4–10 cm latus, obtusus demum late convexus vel subplanus, siccus, fibrillosus vel squamulosus, saepe rimosus, caeruleo-griseus vel obscure cinereus, caro tactu luteo-maculata, lamellae confertae, latae, sinuatae, saepe lutescens, acie saepe cinerescens, stipes 4–8 cm longus, 1–2 cm crassus, aequalis, farctus demum cavus, pallidus, tactu luteo-maculosus, sporae 5 5–7 × 4–5 μ Specimen typicum legit A H Smith, n 15447, prope Ann Arbor, Mich, Sept 27, 1940, in Herb Univ Mich conservatum

Pileus 4–10 cm broad, obtuse when young, becoming broadly convex or nearly plane at maturity, the margin sometimes ele-

vated and wavy, often cracking or splitting radially to the disc, surface dry, glabrous to minutely fibrillose near the margin or with very small appressed or slightly recurved scales over the marginal area, disc appearing glabrous but somewhat streaked and, under a lens, innately fibrillose, occasionally the disc also with very minute blackish scales, color "Quaker-drab" to "pallid mouse-gray" (dark to light bluish gray), disc darker than the margin but not blackish gray, flesh thick, brittle, grayish to drab in the upper part, whitish near the gills, staining pale greenish yellow when bruised, at times the entire cap tinged greenish yellow (usually in age), taste farinaceous, odor slightly farinaceous, lamellae close, broad, adnexed, whitish to pale cinereous, staining pale greenish yellow when bruised (stain very pronounced in fresh young specimens), edge eroded and sometimes staining blackish, stipe 4–8 cm long, 1–2 cm thick, equal or the base slightly enlarged, white or tinged pale grayish, innately fibrillose, no cortina evident, stuffed but becoming hollow, flesh changing to yellowish green when bruised, base white-cottony with adhering mycelium, spores 5 5–7 × 4–5 μ, smooth, ellipsoid, not amyloid, basidia four-spored, cheilocystidia abundant, saccate, fusoid or fusoid-ventricose, 36–52 × 12–18 μ, apices obtuse or acute, pleurocystidia rare to scattered or fairly abundant, saccate to flask-shaped, often ovoid above a narrowed pedicel, 36–40 × 10–15 μ, scarcely projecting from the hymenium, smooth, gill trama and pileus trama both yellowish in iodine and homogeneous

Gregarious on humus in oak woods, Ann Arbor, Nov 4, 1936 (6166), and Sept 27, 1940 (15447)

The bluish gray to dull ash-gray pilei which may become slightly scaly, the lack of a cortina, the pronounced change in color to greenish yellow when the flesh of young pilei is bruised, and the presence of pleurocystidia in addition to the cheilocystidia distinguish this species

I was at first inclined to identify my collections as *T scalpturatum* Fr , but in specimens of that species from M Josserand no pleurocystidia were found, and the cheilocystidia were scarcely differentiated In addition, if one goes back to the Friesian descriptions, certain discrepancies in the macroscopic characters are apparent *T scalpturatum* grows in grassy places under fir in

the mountains, the scales of the pileus become somewhat reddish, and the gills are yellowish only in age or when dried These characters are in direct contradiction to those observed on the Michigan material The absence of a cortina in my specimens may also be significant, but that is a character which might be very easily missed and which might vary from year to year

Tricholoma michiganense, sp nov (Pl VII) — Pileus 5–9 cm latus, obtusus vel convexus, demum subumbonatus, siccus, squarrose squamulosus vel lacerate squamulosus, atro-cinereus, caro alba, tactu rubescens, odore et sapore distinctissimis, lamellae confertae, angustae, cinereae demum pallidae, incarnato-maculatae, stipes 3–8 cm longus, 10–12 mm crassus, aequalis vel subaequalis, solidus, intus obscure cinereus demum pallidus, fusco-fibrillosus, cortina nulla, sporae 6–7 × 3–3 5 μ Specimen typicum legit A H Smith n 15441 prope New Hudson, Oakland Co, Mich, Sept 24, 1940, in Herb Univ Mich conservatum

Pileus 5–9 cm broad, convex to obtuse, expanding to plane or with a low obtuse umbo, margin remaining inrolled for a long time, surface dry and minutely squarrose scaly to lacerate-scaly over the marginal area, disc with matted fibrils, color "fuscous" to "hair-brown" over the disc and on the scales, the whitish flesh showing through the fuscous fibrillose surface covering only near the margin, in age the surface fibrils becoming "drab-gray," the flesh beneath becoming tinged with pale salmon color, flesh thick over the disc, firm, pallid at maturity, pale drab in very young individuals, becoming tinged orange-salmon color in age or when bruised (reaction tardy in some specimens or may not be evident at times), odor similar to that of *Tricholoma sulphureum* but fainter, taste very disagreeable and tardily subacrid, lamellae crowded, narrow (5 mm ±), many tiers of short individuals present (as in Melanoleuca), rounded-adnexed, pale drab in young caps, slowly becoming whitish and in age stained pale salmon color, edges even, stipe 3–8 cm long, 10–12 mm thick above a narrowly clavate base, solid, fleshy, pale drab within at first, whitish in age, surface covered to the apex with "fuscous" fibrils which become more or less torn into lacerated scales, base surrounded by a whitish mycelium which becomes pinkish when bruised, spores 6–7 × 3–3 5 μ, ellipsoid, not amyloid, basidia

four-spored, cheilocystidia filamentose, rare, pleurocystidia not differentiated, gill trama and pileus trama both yellowish in iodine and homogeneous

Scattered on muck soil or around oak stumps on rich humus, La Badie Lake, New Hudson, Oakland Co, Sept 23 and 24, 1940 (15441, type, and 15465)

One of the most curious features of this fungus is that, if one moistens a fragment of the pileus of a dried specimen and then crushes it between his fingers, the odor of coal tar is readily detected, and, in fact, is more pronounced than in the fresh material Whether this character will disappear with age I am not prepared to say, but it is unique so far as my experience with the genus is concerned The flesh did not change color readily in the specimens of collection 15465, but did so very readily in the other I have found occasional specimens of *T orirubens* which also did not change color readily, and I consider this tardiness to be a variation within the species

The outstanding characters of *T michiganense* are the drab colors of pileus and stipe, scaly cap, lack of a cortina (although the pileus may bear a fringe of fibrils along the margin), the color change, and the odor I examined buttons in which the margin of the pileus touched the stipe, but in no case was there evidence of a veil The margin is incurved and the fibrils of the surface of the pileus merely project beyond the incurved margin into the gill cavity The gray fibrillose covering of the stipe extends up to the gills and appears to be independent of the covering of the pileus This is an unusual situation in a species in which both the pileus and the stipe are scaly and the scales similarly colored

T michiganense clearly belongs among the scaly species of the *T terreum* group and apparently is quite similar in appearance to *T atrosquamosum* Both the odor and the taste should separate it at once from that species even if the incarnate tint fails to develop *T orirubens* is distinguished not only by a different taste and odor but also by the lack of a covering of gray fibrils over the stipe

Tricholoma palustre, sp. nov — Pileus 4–8 (9) cm latus, late convexus demum planus vel subdepressus, siccus vel subudus, griseo-olivaceus vel olivaceus, ad marginem luteo-olivaceus;

sapor intense acris, lamellae confertae, sinuatae, latae, pallide luteo-olivaceae, stipes 5–6 cm longus, 1–1 8 cm crassus, aequalis, farctus demum cavus, pallidus vel olivaceo-tinctus, intus albidus, sporae 5–6 × 4–5 μ Specimen typicum legit A H Smith n 15471 prope New Hudson, Mich, Sept 25, 1940, in Herb Univ Mich conservatum

Pileus 4–8 (9) cm broad, very broadly convex with an inrolled margin when young, becoming plane at maturity or remaining broadly convex, occasionally shallowly depressed over the disc and the margin arched, surface moist to dry, appearing matted-fibrillose under a lens, not sticky to the touch, color near "olive-buff" (pale yellowish olive), sometimes "pale chalcedony-yellow" on the margin (very pale yellow with only a trace of green), more grayish olive toward the disc, which is sometimes dirty gray to brownish gray (color persistent in dried material), the gray color apparently being caused by a discoloration of the surface fibrils, flesh thick on the disc, firm, white, grayish just beneath the cuticle, odor none, taste mild at first and not at all farinaceous, tardily becoming very sharply acrid, lamellae broad (10–12 mm), close to crowded, rather sharply adnexed, "pale chalcedony-yellow" to "olive-buff" (almost concolorous with the olive-colored parts of the cap), the edges very eroded, stipe 5–6 cm long, 1–1 8 cm thick at the apex, equal, firm, stuffed, becoming hollow, white within, the exterior whitish or only with a very faint tinge of olive, glabrous to faintly appressed silky-fibrillose, not scaly, spores 5-6 × 4–5 μ, not amyloid, broadly ellipsoid to subglobose, smooth, basidia four-spored, cheilocystidia scattered to rare, saccate and 9–12 μ broad or merely resembling immature basidia, gill trama homogeneous beneath a thin scarcely differentiated pellicle of olive-green nongelatinous hyphae only slightly narrower than those of the tramal body

Scattered on humus at the edge of a bog, La Badie Lake, New Hudson, Sept 23 (15450), and Milford, Sept 25, 1940 (15471, type)

T. palustre was found growing with *T acre* Pk on wet marshy soil at the edge of a bog It is practically identical with *T. acre* in taste, stature, and the appressed fibrils on the surface of the pileus. In wet weather both species may appear moist, but they are properly classified near *T virgatum* The olive color at once

distinguishes *T palustre* from all other species in this group. As in *T sejunctum*, the amount of gray present over the disc may vary greatly depending directly, of course, on the amount of discoloration the surface fibrils undergo

Tricholoma subcerinum, sp nov — Pileus 3–5 cm latus, planus vel umbonatus, glaber, subhygrophanus, alutaceus demum avellaneus, caro aquosa, lamellae confertae, adnatae vel subsinuatae, angustae, subcerinae demum pallide alutaceae, stipes 3–4 5 cm longus, 6–8 mm crassus, cavus, aequalis, impolitus; sporae 3 5–4 × 2 μ Specimen typicum legit A H Smith n 6286, prope Milford, Mich , June 11, 1936, in Herb Univ Mich conservatum

Pileus 3–5 cm broad, plane to slightly umbonate, the margin inrolled, glabrous, moist and watery, "snuff-brown" or slightly paler (dull yellowish brown), subhygrophanous, fading slowly to dull or grayish avellaneous, opaque at all times, flesh soft, watery, concolorous with the pileus both when moist and when faded, thickish, odor none, taste slightly bitterish, lamellae crowded, adnate to sinuate, narrow, "cartridge-buff" when young (very pale yellowish buff), in age nearly concolorous with the pileus, edges even, stipe 3–4 5 cm long, 6–8 mm thick, hollow, fleshy-tough, fibrous, equal, surface toward the apex dull or faintly pruinose, unpolished over the remainder, base white-myceloid, not scaly in age, spores minute, 3 5–4 × 2 μ, ellipsoid, hyaline, smooth, not amyloid, basidia four-spored, 14–16 × 4–5 μ, cheilocystidia and pleurocystidia not differentiated, gill trama homogeneous, yellowish in iodine, pileus trama homogeneous beneath a palisade layer of hyaline pear-shaped cells 15–20 × 8–10 μ, the remainder filamentose and yellowish in iodine.

Scattered on muck at the edge of a bog, Milford, June 11, 1936 (6286)

Although larger, this species is similar to *T fallax* both in having a palisade of upright pear-shaped cells over the pileus and in its very minute spores It differs in its much duller colors and in having the stature of *T melaleucum* From species of the subgenus Melanoleuca it is at once distinguished by its smooth nonamyloid spores and lack of cheilocystidia

Peck's description of *T Thujinum* reads very much like that of *T subcerinum* The type, which has been examined, differs in lacking the palisade of upright cells over the pileus. Through

the kindness of Dr H D House I obtained material for a study of the microscopic details The pileus was found to be homogeneous, the spores smooth, minute (as Peck described them), and not amyloid No pleurocystidia or cheilocystidia were seen The subhymenium was rather rusty brown when revived, but this may have been due to the age of the material and the way it was dried The basidia are very small (15–18 × 3–4 μ)

It is quite apparent that here we have a situation similar to that discovered for *T fallax* Two species with very much the same appearance differ sharply in the structure of the surface layer of the pileus

TRICHOLOMA VENENATUM Atk — Pileus (3) 5–9 (11) cm broad, obtuse to broadly convex when young, expanding to umbonate or plane, the umbo when present broad, the margin often becoming arched or elevated and somewhat wavy, sometimes the margin furrowed in young specimens, surface dry, appressed-fibrillose at first, in age the fibrils becoming aggregated into appressed scales, the scales and fibrils becoming pale sordid brownish ("pinkish buff" to "avellaneous") giving the disc a pale sordid avellaneous sheen, flesh thick, soft, only moderately fragile, white, slowly changing to pale buff but no typical change evident when bruised or broken, odor slightly farinaceous when flesh is crushed, taste bitter and subfarinaceous, lamellae rather close (74–80 reach the stipe), 2–3 tiers of short individuals, moderately broad (7–10 mm), broadly and sharply adnexed, usually with a decurrent tooth, sometimes intervenose, white to cream-color at first, in age pale avellaneous, the edges a bit darker at times and usually slightly eroded, stipe 6–10 cm long, 12–15 mm thick at the apex, solid or hollowed by worms, flesh white, not changing when cut, equal or narrowly clavate, surface white overall, unpolished and obscurely fibrillose, discoloring slightly around the base or where handled (the appressed fibrils discolor as do those on the pileus), spores hyaline, 6–7 × 4–5 μ, smooth, not amyloid, basidia four-spored, cheilocystidia scattered to rare, saccate, smooth, 25–36 × 7–10 μ; pleurocystidia none, gill trama and pileus trama both yellowish in iodine and homogeneous

Scattered to gregarious under brush in wet places on a hillside, Cascade Glen, Ann Arbor, D E Stuntz and A H Smith, July 3, 1940 (15171) I have collected this fungus repeatedly in this one

locality for over a period of years, but not until the season of 1940 did it fruit in sufficient quantity to justify a critical study

The bitterish, somewhat farinaceous, taste has always been a constant character of the specimens from this locality, as has been the color change to brownish Specimens from near Milford which in every other respect appeared to be identical with those mentioned above were mild in taste Since the sum total of all other characters clearly points to the identity of the Ann Arbor specimens with Atkinson's species, it seems best in this instance to disregard taste as a character of major taxonomic importance My detailed description of the bitter form of *T venenatum* is intended to be compared with other accounts of the species and to aid in distinguishing between this form and *T huronense*, to which it appears to be closely related and with which it could be confused

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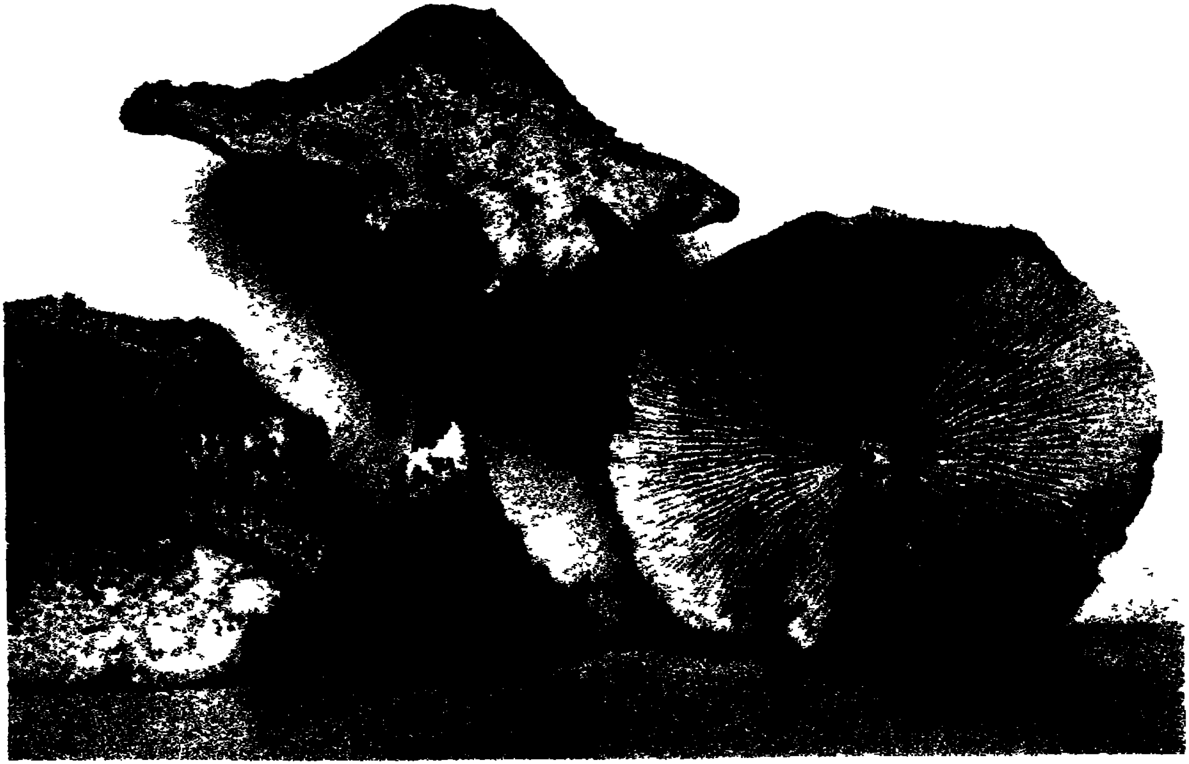
Lepiota cystidiosa Smith × 1 Young specimens



Lepiota cystidiosa Smith × 1 Old specimens

Tricholoma aromaticum Murrill × 1

Tricholoma huronense Smith × 1 Young specimens

Tricholoma huronense Smith × 1 Old specimens

Tricholoma luteomaculosum Smith × 1

Tricholoma michiganense Smith × 1

PLEISTOCENE MOSSES FROM THE AFTONIAN INTERGLACIAL DEPOSITS OF IOWA *

WILLIAM CAMPBELL STEERE

INTRODUCTION

MOSSES and liverworts occur as fossils less frequently than any other large group of plants. The most important reason for their rare fossilization is their relatively delicate and fragile structure, caused by the lack of hard tissues or resistant materials in the walls of individual cells. Furthermore, the plants are small and inconspicuous and, consequently, extremely easy to overlook in fossil material. As a result, only a few traces of the undoubtedly well-developed bryophyte flora of past epochs have been discovered.

The few species of bryophytes which have been reported in a truly fossilized condition (Knowlton, 1902, 1919; Dixon, 1927) date, without exception, from pre-Pleistocene times and occur principally in Tertiary deposits. By far the great majority of fossil mosses thus far reported date from the Pleistocene or very shortly thereafter and are, strictly speaking, in only a subfossil or "humified" condition. Isolated fragments of leaves, branches, and stems have been found embedded in old river and lake silts, and whole plants have been discovered *in situ* in ancient peats and forest beds.

Comparatively little importance has previously been attached to the study of Pleistocene mosses in this country and, as a consequence, few species have been reported. In the glaciated parts of Europe, on the other hand, many accurate and significant studies have been made. The number of species of bryophytes which have been reported from Pleistocene or post-Pleistocene deposits amounts to the rather surprising total of well over three hundred, of which somewhat less than ten per cent are hepatics (Dixon, 1927; Gams, 1932).

In this country the majority of Pleistocene mosses have been reported, not from the most recent deposits, but from the most

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ancient interglacial deposits, a brief history of which follows (cf Kay, 1924, 1929, Kay and Apfel, 1928)

After the retreat of the Nebraskan ice sheet, which, so far as is known, was the first to invade the Mississippi basin, and before the coming of the next or Kansan ice sheet, there was a long interglacial interval Evidence of this is given by the widespread occurrence in Iowa and neighboring states of weathered sands and gravels, old soils and forest beds, and layers of peat and muck, which rest upon the Nebraskan drift, but which in turn are buried by the Kansan till sheet Since these ancient soils and peat beds were first discovered and studied near Afton, Union County, Iowa, the first known interglacial interval, which probably began nearly a million years ago and lasted over a hundred thousand years (Leverett, 1930), was named "Aftonian" Subsequent to their original discovery and identification Aftonian deposits have been reported from nearly forty counties in all parts of Iowa, as well as in Missouri, Nebraska, South Dakota, Minnesota, Wisconsin, and Illinois The deposits have been uncovered in excavations and gravel pits, in road and railway cuts, and have frequently been penetrated by wells, but are only rarely exposed in nature

One of the most characteristic features of Aftonian deposits is the very common occurrence in them of large quantities of well-preserved mosses As a result of earlier studies of Aftonian material several mosses are already known from various parts of Iowa From Dodge Township in Union County (the type locality) have been reported *Camptothecium nitens* and *Drepanocladus fluitans* (Savage, 1903, 1905), from Oelwein in southern Fayette County, *D fluitans* (Beyer, 1896, Macbride, 1896), *D revolvens* and *Calliergon Richardsonii* (Holzinger, 1903), from Iowa City in Johnson County, *D fluitans* var *glaciale* (Holzinger, 1903), from Mud Lake, Emmet County, *D fluitans* var *Jeanbernati* (Grout, 1930), from Wallingford in Winnebago County, *Camptothecium Woldenii* (Grout, 1917) This last-named species is known only from this one locality, and is apparently now extinct According to Dr Grout, the species to which it is most closely allied (*C pinnatifidum*) is not now found east of the Rocky Mountains

In addition to the definite, well-authenticated records just cited many references to bryophytes exist in the literature concerning the Aftonian deposits Since they are mentioned simply as "mosses"

or as occurring in "moss-bearing layers," it is impossible to determine what species are represented (Tilton, 1910, 1911, and others) In the geological surveys of the various counties of Iowa reports of ancient soils which bear mosses occur especially frequently

In addition to the bryophytes from deposits which are almost certainly Aftonian there are reports of several species which somewhat doubtfully belong to that horizon Under this heading come the Dicholyma from Bloomington, Illinois, which, although considered by Dr T P James to be a new species, was not described as such because of its sterile condition (McGee, 1891), and *Drepanocladus aduncus* from Davenport, in Scott County, Iowa (Pratt, 1876)

An interesting collection of Pleistocene mosses was made in Minneapolis, Minnesota, from which have been reported *Calliergon giganteum,* a new species of Drepanocladus, *D minnesotensis*, and a new genus, Neocalliergon, erected for *N integrifolium* (Williams, 1930a, 1930b, Cooper and Foot, 1932) Although it is stated that this material came from deposits believed to date from late Pleistocene, the novelty of such a large part of it arouses a suspicion that they might possibly be Aftonian Leverett (1932) remarks that Aftonian deposits have been found relatively close to the surface farther south in Minnesota He says "At several places in southeastern Minnesota and neighboring parts of Wisconsin and Iowa there are soils and beds of peat and muck between till sheets, which have been commonly referred to the Aftonian interglacial stage Among the earliest brought to notice are those of western Fillmore County and southern Mower County, Minnesota, discussed by Winchell As a rule the bed of muck and peat is found at the moderate depth of 20 to 30 feet The greatest depth noted is 50 feet, the least is only 7 feet" "Another exposure of a peaty bed between tills is found in a cut on the Chicago, Rock Island & Pacific Railroad 2 miles southeast of Fairbault, Minn Above the soil is 20 feet of bluish till "

Professor C O Rosendahl, of the University of Minnesota, has told me (*in litt*, 1939) of collecting plants in deposits of Aftonian age in Minnesota, and I have seen mosses from these collections

Other deposits which might possibly be relics of Aftonian times are those in the vicinity of Toronto, from which several species of mosses have been reported (Hinde, 1877, Dawson and Penhallow,

1890, Penhallow, 1896, 1900, Coleman, 1894, 1895) These deposits are so close to the gathering grounds of the ice sheets that much of the evidence for their position in the Pleistocene is lacking Consequently it is exceedingly difficult or impossible to correlate exactly these deposits with those at the margin of the glaciated area

Mosses which certainly date from interglacial stages in the Pleistocene later than the Aftonian have been reported from Ohio (Orton, 1870), Wisconsin (Cheney, 1930, 1931, Wilson, 1932, 1935, 1936), Minnesota (Winchell, 1888), Alaska (Cooper, 1923), District of Columbia (Williams, 1933), and Louisiana (Steere, 1938b)

The few records of fossilized postglacial mosses in North America occur principally from travertine or tufa deposits in Oklahoma (Emig, 1918) and Utah (Flowers, 1933)

MATERIAL

The material to be discussed here was collected in the type locality of the Aftonian interglacial stage near Afton, Iowa, during the summer of 1933 Since the collectors, Dr Ethel B Hansen and Dr Gladys West, were primarily interested in the identification of the species of higher plants, the large collection of mosses was turned over to me for study

The mosses occurred in thin layers in a clayey silt, which is clearly varved They were not equally distributed through the whole section, which was several feet thick, but were highly localized The layer in which they were most abundant was called by the collectors "Layer C," and from it came the great majority of the species listed in this paper The thinness of the varves and the types of mosses preserved indicate the margin of an ancient boggy lake or a slow-moving bog stream

The moss-containing fragments of clay were carefully washed in a sieve or strainer, to remove most of the dirt from the plant débris, which was then sorted The mosses were received for study in this cleaned condition, but had not been given chemical treatment of any kind The specimens were yellowish to clear reddish brown when wet, and so fragile that they could be handled only by small brushes When dry, they were light, dusty brown and crumbled into fragments if touched

In order to facilitate the study of the specimens each fragment of branch or stem was partially dissected to show all diagnostic de-

tails of the leaves necessary for identification, as, for example, their attachment to the stem and the cellular areolation of base and apex The dissections were mounted in a dark glucose syrup ("Karo") under a glass cover slip This technique for mounting fossil materials, which was originated many years ago by Professor H H Bartlett, results in hard, permanent mounts In the thin layer under the cover glass the dark syrup is entirely transparent and appears colorless The advantage of the dark syrup is that it never crystallizes, which is the greatest fault of water-glass or pure glucose-syrup mounts

In general, the material is in remarkable condition, especially since it must have been carried about by water currents before being finally covered with silt Many of the stems are exceedingly flattened, so that their cell structure and arrangement are not easily recognizable, and the apices of occasional leaves have been frayed or destroyed Rarely, fungous hyphae are visible (Pl V, Fig 5) The wonderful preservation of mosses in Aftonian deposits, approximately a million years old, has excited considerable comment Grout (1917) remarks upon the unusual condition of specimens of *Camptothecium Woldenii* "The material is somewhat coated with fine soil, although Mr Wolden says he washed it out from lumps of earth Otherwise it might have been collected one hundred days ago instead of having been preserved one hundred thousand years, more or less The plants are green, although no cell contents are observable, and the leaves are perfectly preserved, even to all details of cell structure In fact it seemed so incredible that a moss could have remained so well preserved under such circumstances, that I wrote again to Mr Wolden for additional details"

Professor Macbride (1896) gives an even more graphic (and extravagant) description "The bottom of the seam is a compact mass of moss, compacted and pressed together no doubt, but absolutely untouched by putrefaction or decay, perfect in every leaf and fiber as any herbarium specimen in the world Specimens you may examine show this perfectly. You may see the stem, the attachment of the leaves, the innovations, the form of each leaf, nay, the very areolation of a leaf apex and base, quite as absolutely defined as in the case of any freshest specimen one may bring in now from any living turf or forest bed For this reason, we are able with much confidence to identify the species concerned, although, so far,

we have seen no smallest sign of capsule or fruit So far, also, all the material seems to represent but a single species, a *Hypnum*, probably *Hypnum fluitans* "

In the following list of mosses which have been recovered from the Aftonian material collected by Dr Hansen and Dr West four species seem sufficiently distinct from their known modern relatives to deserve specific recognition, and so are here proposed as new species Of course, there are widely divergent methods of considering the extent and limits of species in fossil material (Bailey, 1933), just as there are in the the study of modern plants In modern bryology suitable and fairly satisfactory diagnostic criteria and concepts of specific boundaries exist, which, fortunately, can be readily adapted to Pleistocene material It is difficult to agree with Gams (1932), however, who says somewhat arbitrarily "None of the more experienced bryologists of today venture to create new Quaternary species of the polymorphic Amblystegiaceae, which seem to have existed in Europe almost unchanged since the Miocene" In the first place, the majority of species reported from Pleistocene deposits are known from the Tertiary in North America and, furthermore, many which are called preglacial are very probably really interglacial in age, but from outside the limits of glaciation, or else from deposits not yet recognized as being interglacial, so that Gams' statement seems unfounded In the second place, two of the most experienced bryologists in this country have named new Quaternary bryophytes Dr Grout, an authority on the family Brachytheciaceae, has named a new species of Camptothecium from Aftonian material, and R S Williams, also a widely recognized bryologist, has described not only two new species, but also a new genus from Pleistocene material, and all of them in the Amblystegiaceae It is remarkable that so small a number of North American collections should contain so many interesting species, when many more years of careful and intensive study of European subfossil bryophytes have brought to light a smaller number of new types, which are not even generally accepted This conspicuous discrepancy between the moss floras of the earliest known interglacial stages of the two hemispheres is difficult to understand, and is of considerable significance

It is probable that, just as with the phanerogams, whole groups which existed in Tertiary times, but which are now nearly or com-

pletely extinct, persisted into the early part of the Pleistocene There has been sufficient time for many changes to have taken place since the beginning of Pleistocene times, which was, according to one of the most recent calculations (Leverett, 1932), at least a million years ago Baker (1920) says "It is believed that upwards of a million years have elapsed since the first great field of ice covered the country, a period of sufficient length to permit great changes in the species of plants and animals inhabiting the region" This is well shown by the tremendous differences which have occurred in the mammal fauna since early in the Pleistocene During this time more than ninety-five per cent of the species of mammals have become extinct Nevertheless, the gastropods, or at least their shells, have not been modified appreciably during the same time, which is accounted for by the fact that a shell is an exceedingly conservative structure whose evolution throughout geological history has been very slow In the amount of change which they have undergone the mosses occupy a place intermediate between the very plastic mammal group and the nearly static gastropod group The history of the phanerogamic plants, especially in North America, is so imperfectly known that very little can be said concerning the changes which they have undergone, except that their representation in Tertiary times was, both specifically and geographically, considerably different from the situation now

TAXONOMIC DISCUSSION OF THE MOSSES

Most of the fossil mosses studied here have been identified with the help of various descriptive manuals designed for present-day species, especially Grout's *Moss Flora* (1928–40), and through comparison with modern specimens In order to facilitate the comparison with such a large bulk of material, permanent slides were made of a series of the modern species most closely related to the fossils

The Sphagna occurred as small tangled mats of branches and stem fragments, very rarely as complete leafy stems They could usually be easily distinguished from the other mosses macroscopically because of their grayish appearance, even when wet, instead of the reddish-brown color of the other mosses Since the stems and leaves were flattened and extremely fragile, it was impossible, in the usual manner, to make the sections of leaf and stem necessary for exact specific determination It was in general possible, therefore, to

recognize only the group to which the species belongs, or the "large" species A detailed investigation of this material by means of regular histological methods would undoubtedly make possible the identification of many more species It would be necessary, however, to section material embedded in paraffin or celloidin

List of Species

SPHAGNACEAE

SPHAGNUM SQUARROSUM Crome — Branches of this species were easily recognized by the large, squarrose branch leaves

Present distribution — Greenland, Labrador, Alaska, Canada, south to the northern United States

SPHAGNUM ACUTIFOLIUM Ehrh (*sensu lato*)

SPHAGNUM CYMBIFOLIUM Crome (*sensu lato*) — These long-recognized "species," as understood by the earlier bryologists, are now believed to consist, in reality, of whole groups of species, most of which have a decidedly northern range

FISSIDENTACEAE

FISSIDENS SP — Only one specimen belonging without question to this characteristic genus was found (Pl I, Fig 1) The plants are badly damaged, but show the typical sheathing leaves, which are unbordered (Pl I, Fig 2) and have cells 10–12 μ in diameter The specimen is somewhat small to agree well with any of the modern boreal American species having these same characteristics Nevertheless, I suspect that it is some form of the variable *Fissidens osmundioides* Hedw , which is widely distributed through the northern United States and Canada

DICRANACEAE

DICRANUM BERGERI Bland — The specimen so named has the upper leaf cells nearly as broad as long, the costa not reaching the leaf apex (Pl I, Figs 3–4), and bears only a few serrations on the dorsal side of the leaf at the apex (Pl I, Fig 5) It is certainly not in the relationships of the ubiquitous and protean *Dicranum scoparium* Hedw , whose forms have elongated and pitted leaf cells

Present distribution — In bogs, Labrador to Alaska, Canada, southward into the northern United States, a boreal to sub-Arctic species

BARTRAMIACEAE

PHILONOTIS SP — Only one very small specimen was found, which was recognized by the unbordered leaves and characteristic papillae formed by projecting angles of the wall at the ends of the cells It does not agree very well with any of the modern species in its plane leaf margins and the rather blunt leaf apex (Pl II, Figs 1-3), but any attempt either to propose a new species or to identify an old one from such imperfect material would not repay the trouble The representation of this genus here is of significance, however, since the species of Philonotis grow in very moist places, or even in water, although never in running water

AULACOMNIACEAE

AULACOMNIUM PALUSTRE (Web & Mohr) Schwaegr — This species was well represented in the collection by many specimens in various states of preservation Even when the leaf apex (Pl I, Fig 6) was lacking the species could be recognized easily by the characteristic thick-walled cells with a central papilla (Pl I, Fig 7) and by the tomentose stems In view of its present common and widespread association with *Aulacomnium turgidum* (Wahlenb) Schwaegr in sub-Arctic America, it is surprising not to find it represented in the Aftonian material

Present distribution — On the ground in swamps and bogs, North America from the Arctic Archipelago south to Florida in the east and to California in the west

FONTINALACEAE

FONTINALIS SPP — Since only small pieces of plants belonging to this genus were found, it was impossible to determine whether or not they originated from the main stem or from the branches Hence it was considered unwise to attempt to name them, although at least two different species are present in the collection All modern American species of Fontinalis are aquatic, growing typically in running water, and are characteristic of temperate regions, not reaching even the sub-Arctic zone.

THUIDIACEAE

ANOMODON ATTENUATUS (Hedw) Hüben — There is no doubt about this identification, since the areolation, the leaf shape, and the characteristic attenuate branches (Pl II, Figs 4–5) agree very well with those of modern material

Present distribution — On soil, base of trees, rotten wood, and rocks, very widely distributed in temperate North America

THUIDIUM DELICATULUM (Hedw) Mitt — This identification is beyond question, since the several specimens show the bipinnate and tripinnate branching of the stem, the characteristic papillae of the leaf cells, the paraphyllia, and the stem leaves typical of the species (Pl V, Figs 1–2) The most closely related American species is *Thuidium recognitum* (Hedw) Lindb , which grows in rather dry places

Present distribution — On soil, rotten wood, and rocks, usually in moist or wet places, widespread throughout North America east of the Rocky Mountains

AMBLYSTEGIACEAE

CALLIERGON STRAMINEUM (Brid) Kindb — Slender, unbranched plants with leaves imbricated above and spreading below, obtuse and somewhat cucullate at the apex, the costa ending well below the leaf apex, and the alar cells well developed, were placed here In none of the specimens did I see the radicles produced from the dorsal side of the leaf apex, typical of living material

Present distribution — In bogs at high latitudes and high altitudes, Greenland to Alaska, southward to the northernmost United States

CALLIERGON CORDIFOLIUM (Hedw) Kindb — Plants with little-branched stems, spreading leaves with the costa percurrent or nearly so, and the alar cells inflated, but not sharply demarcated from the adjoining cells, were so named Many of the specimens compared very well with modern material

Present distribution — In swamps and bogs, throughout boreal North America, extending southward into the northern United States

CALLIERGON RICHARDSONII (Mitt) Kindb — Many forms were found which resembled *Calliergon cordifolium* in many ways, but in which the leaves were shorter and broader, and the costa extended only about half the length of the leaf Such forms are grouped together here, although there may be at least two species or subspecies represented

Present distribution — In bogs and on wet rocks in the mountains, a truly boreal species, Newfoundland, Prince Edward Island, Greenland, Hudson Bay, south to the very northernmost United States

CALLIERGON GIGANTEUM (Schimp) Kindb — The branch leaves of this species are much longer and narrower than the stem leaves, so that isolated branches, which make up the greater part of the material, could have been named only doubtfully if they had not been checked against present-day material When whole plants occur, however, the pinnate branching, the percurrent costa, and the sharply demarcated auricles of inflated alar cells make the determination certain (Pl V, Fig 6)

Present distribution — In bogs, a distinctly boreal species widespread in northern North America, extending southward to the northern United States

Calliergon aftonianum, sp nov — Plant apparently large, pinnately branched, with the habit of *Calliergon giganteum,* basal leaves oblong, obtuse, 1 mm long and 0 5 mm wide (Pl III, Figs 1–2), costa very short or even lacking, apical leaves of branch longer and narrower, lanceolate, up to 2 mm long and 0 3 mm wide, costa extending about one half the length of the leaf, but never percurrent Known only from isolated branches Slide 64 is designated as the type

This species is closest to *Calliergon giganteum* in its mode of branching and in the similar alar cells, but differs conspicuously and consistently in the longer, narrower, less triangular leaves, which have a much shorter costa

Calliergon Hansenae, sp nov — Stems long, lax, irregularly pinnate, with somewhat attenuate branches, leaves narrowly lanceolate, 1–1 7 mm long, the average length about 1 5 mm , costa short, to one half the length of the leaf, apex obtuse to obtusely acute, alar cells very conspicuous Type, slide 106

This species is probably most closely allied to the preceding

one or to *Calliergon giganteum*, but is very lax and much resembles some of the forms of Drepanocladus, from this it differs, however, in the peculiar arrangement of the apical leaves, which are mostly obtuse and not at all secund (Pl III, Figs 3–4) It approaches Drepanocladus especially in the elongated alar cells (Pl III, Fig 5), a feature not ordinarily found in Calliergon, also in the long, narrow leaves and short costa

CALLIERGON TRIFARIUM (Web & Mohr) Kindb — A number of specimens of this species were recognized through their broad, imbricated leaves, which lacked well-defined alar cells and in which the costa was not percurrent The spirally trifarious leaf arrangement easily seen in living specimens was not obvious in the fossil material, because of the flattening

Present distribution — Greenland, across Arctic Canada to Alaska, reaching only the very northernmost United States

CALLIERGON TURGESCENS (Schimp) Kindb — The abundant specimens of this species were easily recognized from their large size and the very much inflated, turgid appearance of the leafy stems Under the microscope the leaves show the porose, thick-walled alar cells, the short, thin costa, and the minutely apiculate apex The curious apiculus is usually missing from older leaves, but may be demonstrated in the terminal leaves, which are not only younger but also better protected from fraying

Present distribution — In cold bogs, Greenland, Arctic and sub-Arctic Canada

Calliergon Kayianum, sp nov — Leafy stem relatively large, turgid, 3–5 mm in diameter, in fragments 0 5 to 2 cm long, rarely branched, usually bearing at the apex a caducous, budlike structure, leaves widely ovate to nearly orbicular, 2–3 mm long, 1 5–2 0 mm wide, averaging 2 5 mm long and 1 7 mm wide, but narrowed to the somewhat clasping insertion, apex broadly rounded, not at all acute or apiculate, costa completely lacking (Pl. IV, Figs. 4–7)

This species, which is one of the most common in the collection, and certainly the most conspicuous, much resembles in habit both *Scorpidium scorpioides* and *Calliergon turgescens* From the former it differs in the symmetrical, not at all secund, leaves, and from the latter, to which it is most closely related, in the nonapiculate leaves with no trace of a costa An interesting

relationship to *C turgescens* is shown by the production of extremely easily detached buds at the end of the large main stem According to Grout (1931), *C turgescens* has the habit of "reproducing asexually by the falling off of the terminal buds of slender stolons" The big detached buds of *C Kayianum* make up a great part of the Aftonian material From the very large variety *gigantea* of *Fontinalis antipyretica* it differs in that the leaves, although concave, are not at all keeled-conduplicate

Calliergon Kayianum belongs, perhaps, in Williams' new genus Neocalliergon (Williams, 1930a, 1930b), but in view of the great variability, which was apparently characteristic of the complex which we now call Calliergon, during Aftonian and perhaps during later interglacial stages, it is somewhat unsafe to draw too finely the lines between genera There were apparently whole groups or lines of development which have not persisted into modern times In the Calliergon material several types apparently represented other unknown species, but were insufficient in quantity or too poorly preserved to be described as new A study of Calliergon from a much larger collection than this might shed a great deal of light on the origin of the genus and its relation to Drepanocladus Many specimens were found which possessed characteristics of both Drepanocladus and Calliergon, and appeared intermediate between them This fact seems to point to a common ancestry for both groups rather than to a parallel development as a reaction to the same environment, as is believed by many bryologists

DREPANOCLADUS ADUNCUS (Hedw) Warnst — Forms with entire leaves and large groups of well-developed alar cells are placed here Although a great number of forms, including the so-called varieties *Kneiffii* and *polycarpus*, were found, no attempt was made to separate them, because of their infinite variability

Present distribution — Widespread almost throughout northern North America, usually in water

DREPANOCLADUS FLUITANS (Hedw) Mönkem — Forms with serrulate leaves and relatively small areas of alar cells are grouped here

Present distribution — Common throughout Canada and the northern United States

DREPANOCLADUS EXANNULATUS (Gümb) Warnst — Specimens with

serrulate leaves, a strong costa, and conspicuous auricles of alar cells are placed here

Present distribution — Distinctly boreal, Greenland, Canada, reaching only the northernmost United States

DREPANOCLADUS REVOLVENS (C Müll) Warnst — This species is characterized mainly by the strongly falcate-secund leaves which have no well-differentiated alar cells The dark red to nearly black characteristic of living plants persists in the fossil specimens

Present distribution — A rather uncommon species of boreal bogs, throughout northern Canada, but reaching only the northernmost United States

Drepanocladus apiculatus, sp nov — Stems rather robust, little branched, leaves 1 5–2 0 mm long, 0 5–0 7 mm wide, ovate, tapering to a gradual acumination, at the termination of which is a narrow, often recurved apiculus (Pl V, Figs 3–4), very concave, falcate-secund, not plicate, alar cells thick-walled, but otherwise not much differentiated, costa very short, to one half the length of the leaf, rarely more (Pl V, Fig 5) Type, slide 183

This species is apparently most closely related to *Drepanocladus revolvens*, but differs in the peculiarly recurved apiculus and the short costa So far as I know, no modern species of Drepanocladus has an apiculus on its leaves, although this characteristic still persists in Calliergon

In the Drepanocladus material there are countless variations and forms which might have been identified, or at least named, most of them under *D aduncus* and *D fluitans* The genus Drepanocladus is still so variable and so plastic, however, that it was considered inadvisable to attempt to segregate varieties and forms from material which grew under conditions which are still not fully understood As Grout (1931) says of the modern specimens "Nearly all grow in water or very wet places, and the amount of water and other conditions of their immediate environment appear to modify their growth profoundly Sometimes two well marked varieties can be found on the same plant "

It appears that, although the genus Calliergon has become somewhat stabilized during the past million years, perhaps by the extinction of intermediate forms, Drepanocladus is still nearly as plastic now as it was during Aftonian times

SCORPIDIUM SCORPIOIDES (Hedw) Limpr — This large species, al-

though not common, is represented by several specimens, which are easily recognized by means of their large size and the secund leaves without a costa

Present distribution — In swampy and boggy streams and pools, Canada and the northern United States, across the continent

AMBLYSTEGIUM JURATZKANUM Schimp — Only a single fragment of this small but easily recognized species was recovered The spreading leaves and the characteristic alar cells are distinctive

Present distribution — Widespread through the northern United States and Canada, on rotten wood, moist humus, and stones

LEPTODICTYUM RIPARIUM (Hedw) Warnst — The specimens placed here agreed in most respects with modern material, except that some of the leaves are distinctly serrulate, especially toward the base The apical cells are frequently much shortened, and the remaining cells are shorter than is usual in Drepanocladus, which seems to preclude that genus, a view substantiated by the lack of inflated alar cells This identification was not considered to be completely beyond question, but the material is too fragmentary to justify the creation of a new species

Present distribution — Common throughout the United States and southern Canada

CAMPYLIUM STELLATUM (Hedw) Lange & C Jens — The large leaves with costa short or absent and the numerous quadrate alar cells are well shown in the very large number of specimens present in the Aftonian material (Pl II, Fig 6, Pl IV, Fig 3) Reasonably long branches occur which have the typical leaf arrangement

Present distribution — Throughout Canada, from the Arctic Archipelago south to the northern United States

BRACHYTHECIACEAE

CAMPTOTHECIUM NITENS (Hedw) Schimp — This species was apparently very common and abundant in Aftonian times, to judge from the quantities of it which are found in fine condition in this material The plications of the leaves and the abundant tomentum on the stems are extremely well preserved.

Present distribution — From the Canadian eastern Arctic southward to the northernmost United States

CAMPTOTHECIUM WOLDENII Grout — Although the type specimen was not seen, several specimens were found which seemed to agree completely with the original description of this species (Grout, 1917)

HYLOCOMIACEAE

HYLOCOMIUM SPLENDENS (Hedw) Bry Eur — This species is one of the best preserved and most easily recognized in the whole collection Even the paraphyllia on the stems are still beautifully preserved, and the double costa is conspicuous (Pl IV, Figs 1–2)

Present distribution — Canada and the northern United States, still occurs in Iowa

POLYTRICHACEAE

POLYTRICHUM STRICTUM Banks — The identification of this species is facilitated through the tomentose stems and the well-preserved leaves with clearly incurved margins, as well as through the mosses associated with it, since they are bog species *P juniperinum*, although very similar, lacks the tomentum on the stem and grows in fields and woods, not ordinarily in bogs

Present distribution — Distinctly boreal, growing in Sphagnum bogs and swamps, Greenland, Canada, northern United States

THE MECHANICS AND CHEMISTRY OF MOSS PRESERVATION

A curious and striking feature of the material just described is the complete and conspicuous lack of certain species, genera, and even whole families of mosses, and of the entire group of hepatics which should certainly be expected on the basis of modern association and distribution of bryophytes For instance, in our modern boreal bogs there are usually associated with the mosses listed above such genera as Leucobryum, Pellia, Cephalozia, Calypogeia, Lophozia, and Mylia Since these forms are completely unrepresented in early Pleistocene deposits, it is of course possible to conclude that they were actually lacking during Aftonian times This conclusion would be almost certainly incorrect, however, because the groups just mentioned are highly developed ones, and, furthermore, to judge by their present wide distribution, must be ancient ones Since the fossil species occurred in the same associations in which they are still found in nature today and since the hepatics are an old group,

it is reasonable to suppose that the missing species were then present, but for some reason were not preserved The lack of certain characteristic bog mosses, such as Leucobryum, is so consistent that it appears not to be by accident, but through some idiosyncrasy of the species The matter of which species are preserved seems to be correlated definitely with the chemical constitution of their cell walls, which in general are much less resistant to hydrolysis than those of higher plants The cell walls of mosses and hepatics are not made of as permanent and resistant materials as those which compose the cell walls of higher plants, but consist in large part of hemicelluloses, which are usually more easily broken down than true celluloses (Müller, 1905) Hepatics contain even less true cellulose than mosses — only one sixth as much (Lohman, 1903)

According to the long-accepted views of botanists and geologists, peat formation simply amounts to the accumulation of celluloses, hemicelluloses, and their oxidation products The complete acceptance of this view is reflected by many workers Weyland (1925) says "Die schlechte Erhaltung und das Fehlen fossiler Moose überhaupt wird durch die chemische Zusammensetzung der Zellmembranen der Moose erklart, die zum grossten Teil nicht aus echter Cellulose bestehen und daher leichter zersetzlich sind "

Rather recently, however, the theory that lignins and their derivatives and, to a much lesser extent, resins and waxes are the materials which persist and accumulate (Fischer and Schrader, 1921) has been gaining ground, especially among chemists The term "lignin" has been restricted in the past by plant anatomists and morphologists to a somewhat obscure material which is located in secondary thickenings of cell walls and which can be identified by microchemical tests The same term is used by chemists in a much broader yet specific sense, to cover the aromatic constituents of the cell wall which are characterized upon degradation by the methoxyl group (Fuchs, 1926) This widely conflicting usage and concept is strikingly illustrated by comparing the older chemical analyses of bryophytes by qualitative microchemical methods with more recent analyses on the basis of quantitative tests None of the early analyses show (Roberts and Haring, 1938) the presence of lignin in bryophytes, whereas the latter demonstrate large amounts of lignins or their derivatives, as determined from the methoxyl content In fact, more "lignin" is reported for mosses than from some phan-

erogams! For example, Waksman and Stevens (1928), in a study of peat-forming materials, report that "*Hypnum*" contains 21 13 per cent of lignin, whereas "*Sphagnum*," in the upper, growing, portion and the lower, dead, portion, contains, respectively, 6 97 and 19 15 per cent of lignin In *Sphagnum cavifolium* and *S medium* have been reported, respectively, 9 2 and 16 14 per cent of lignin (Stadnikow and Baryschewa, 1930a, 1930b)

Czapek (1899, 1913) reported the occurrence of aromatic constituents, which are now considered to be lignin derivatives, in the cell walls of bryophytes, and found that there is a distinct correlation between the habitat and the type of aromatic compound present In mosses living in the water or in moist or deeply shaded places he found a material which he named "sphagnol" and which was demonstrated to be strongly toxic to bacteria, fungi, and other organisms In truly xerophytic mosses, on the other hand, sphagnol is lacking There occurs a tannin, called "dicranic acid" by Czapek, which is toxic, like sphagnol, but to a lesser extent In the hepatics, however, there seems to be very little relation between the chemistry of the cell wall and the habitat of the species

Since peat formation, which is the accumulation of plant residues, probably of an aromatic nature, can take place only under anaërobic conditions (Waksman and Stevens, 1928), the aquatic species obviously stand a much better chance of becoming preserved In the list given earlier, for example, nearly all the species are either actually aquatic or from very moist habitats All species which are prevented from being deposited under water, even though they contain the necessary lignins or lignin derivatives, will still not be preserved As a result, species of the moist but rarely inundated forest floor are found in a fossil or subfossil condition much less often than aquatic species Progressively, xerophytic mosses such as Grimmia and most species of Rhacomitrium are preserved only under exceptional conditions, and could not be expected to occur in peat at all For this reason the two most important factors which determine preservation of mosses are their deposition in water and the presence of lignins or related compounds in their cell walls

Weyland, in his discussion of the poor preservation of mosses in general, has placed significance upon the fact that the moss plant is a gametophyte and thus is ontogenetically different from the ferns and the phanerogams Although this viewpoint opens some interest-

ing philosophical questions, the moss sporophyte apparently does not have a more resistant cell wall than the gametophyte. This is well illustrated by the almost complete lack of moss sporophytes in known fossil material. It has also been shown that the young sporophyte, at least, contains materials which are easily decomposed (Ziegenspeck, 1926). The true cause of the poor preservation of mosses is undoubtedly that both generations lack the large amounts of resistant vascular and cuticular tissues that are characteristic of the higher groups.

THE CLIMATE OF THE AFTONIAN INTERGLACIAL STAGE

In addition to its purely taxonomic phase, the study of Pleistocene mosses has considerable bearing on the problems of climate and plant distribution during the interglacial intervals. Most mosses are very sensitive to the various environmental factors and, furthermore, usually have a fairly restricted geographical range, as has been pointed out in some detail during the last few years (Steere, 1937a, 1937b, 1938a, Sharp, 1939). Consequently fossil mosses make accurate and convenient indicators of the climatic and ecological conditions under whose influence they grew. Their value in climatic studies of the past has not been sufficiently recognized.

The question of the nature of the climate and life of the interglacial stages is an exceedingly fascinating one, which has had several different and more or less conflicting answers. Savage (1903) says of the plant remains from Dodge Township, Union County, Iowa: "The scarcity in these deposits of fragments of our deciduous forest trees and the presence, in abundance, of leaves and twigs and pieces of wood of cone-bearing trees, such as live at present at higher latitudes, is significant. The absence in these beds of the aquatic moss species that predominate today in the lakes and pools of Iowa, and the occurrence there of species of mosses which now flourish further northward, furnish strong evidence that during the Aftonian age the climate of our state was favorable for the growth of a more boreal vegetation than at present." He continues: "The conclusion seems warranted that many of the plants which are found in the present flora of our state had no place there during the earliest interglacial interval, and that, at our latitude, the climate never became so mild and genial throughout this period as that which the region enjoys during the present age."

Later, Savage (1905), while discussing more Aftonian plants, this time from Oelwein, in Fayette County, Iowa, supports and extends his original opinion, saying "It is worthy of note that the moss species, whose remains were found in the second member of the section, as well as the pieces of larch wood that came from the horizon of the old Aftonian surface, are forms that thrive at present in more northern latitudes It is probable that the climatic conditions of the Aftonian interglacial age were, at least toward the close of the interval, less mild and genial in this portion of our country than those which the region has enjoyed in recent times" This view is convincingly supported by the plant materials that have been studied since, in fact, it seems impossible to interpret the evidence otherwise

Little has been said concerning the vegetation of the Aftonian interval as a whole Shimek (1910) speaks of "plant-covered land areas similar to those which now prevail in the region," and Baker (1920) considers that "the Aftonian was a time of luxuriant forests"

The Mosses

The modern bryophyte flora of Iowa has been somewhat intensively studied during the last few years, and therefore is rather well known (Bessey, 1884, Savage, 1898, Shimek, 1898, 1907, 1915, Conard 1912, *et seq*, Wolden, 1919, Cavanagh, 1921, *et seq*, Blagg, 1927, *et seq*, Grout, 1928, Conard and Wolden, 1932, Sayre, 1934)

The great majority of the present Iowan mosses are the same ones that are found in similar habitats throughout Illinois, Indiana, Ohio, and southern Michigan and Wisconsin Fewer species are reported from Iowa than from any of the states adjacent to it on the east, probably because of the relative scarcity of proper habitats in Iowa and its smaller annual rainfall As might be expected on the western side of the Mississippi, a slight but perceptible western or southwestern element occurs in the moss flora. The most characteristic indications of such an element are all in the family Funariaceae, namely *Physcomitrium Hookeri* Hampe, *P Drummondii* E G Britton, *Pyramidula tetragona* (Brid) Brid, and *Funaria calvescens* Schwaegr

The relatively small number of species reported from Iowa and the scarcity of unusual species are directly related to the widespread occurrence of only two main types of habitat prairie, either wet or dry, and occasional open woods Naturally the mosses are types

characteristic of these habitats, with very few bog or aquatic species represented In one region of Iowa, and there only, the moss flora departs from this simple formula and is really diversified This is in the so-called unglaciated area in the extreme northeast corner of the state, where a number of interesting species have been reported (Blagg, 1928a, 1928b, Conard, 1932a, 1932b, 1938) The wonder is not, however, that interesting species have been found there, but that there are so few of them, when one considers the large number of unusual mosses collected by Dr Holzinger at Winona, Minnesota, not a great deal farther north in the same driftless strip along the Mississippi River *Bryoxiphium norvegicum*, for example, is almost certain to turn up in northeastern Iowa (Steere, 1937b)

One of the most characteristic features of the present-day Iowa moss flora is the scarcity of aquatic and bog bryophytes Pammel (1909) says "There are none of the typical moss bogs found in this state *Sphagnum* has not been found anywhere in the bogs of northern Iowa" Even though two species of Sphagnum, *S medium* and *S cuspidatum*, have recently been reported from Iowa (Cavanagh, 1929a, 1929b), Pammel's last statement still holds true, since they came from wet banks in woods in Muscatine County, which is in the easternmost part of the state and outside the Wisconsin drift area Thus the bogs are apparently of a nature quite different from those farther north Beyer (1909), in discussing the peat bogs of Iowa, with special reference to their economic importance, says "While in high latitudes and high altitudes the club mosses, sphagnums and hypnums contribute very largely toward the accumulation of peat, grasses and sedges are much more important in Iowa peat bogs Mosses are present occasionally, but play a secondary role" This essential and fundamental difference between the modern bogs of Iowa and the extinct boreal ones is very noteworthy The boreal type of bog, as exemplified in northern Minnesota, Wisconsin, and Michigan, and from there north into the Arctic, abounds in all types of bryophytes and is probably richer in species than any other type of habitat in the glaciated region, a striking contrast to vegetation in Iowa today

All the mosses yet reported from Aftonian deposits, together with those discussed in another section of this paper (pp 82–90), have been species quite characteristic of boreal bogs. This is emphasized by the fact that most of them, including the Sphagna, no longer occur

in Iowa An examination of their present geographical distribution should demonstrate convincingly that the majority of them are boreal or sub-Arctic species The most characteristic northern mosses from Aftonian deposits in Iowa are *Dicranum Bergeri*, *Calliergon stramineum*, *C giganteum*, *C cordifolium*, *C Richardsonii*, *C trifarium*, *C turgescens*, *Drepanocladus exannulatus*, *D revolvens*, *Scorpidium scorpioides*, and *Camptothecium nitens*

Higher Plants

During the Aftonian interglacial stage nearly the whole state of Iowa must have been covered by a dense coniferous forest of a strictly boreal nature At least this is the conclusion to be drawn from the fossil material recovered from Aftonian deposits It is demonstrated by the widespread occurrence of wood fragments, logs, and stumps, as well as leaves, twigs, and cones, in an area where there is no natural forest now In parts of central and southern Iowa, where there have been no forests within historical times, the old forest bed is so well preserved that fully fifty per cent of the excavations penetrating to its depth reveal it *in situ*, whereas nearly all the rest contain battered logs and sticks (McGee, 1891, Baker, 1920) In some places the water in nearly every well is flavored by products of the slow decomposition going on in the forest layer which is penetrated by the wells In fact, much of the water in such areas is rendered unfit for drinking because of remains from this forest of approximately a million years ago

The species of conifers that have been recognized from the débris of the old forests are *Larix laricina* (Macbride, 1896), *Thuja occidentalis* (McGee, 1891), *Picea mariana* (Macbride, 1907), and *P canadensis* (Macbride, 1907) It is important to notice that these boreal forests, which probably indicate a rather poorly drained region, extended in Aftonian times to the southernmost edge of Iowa and perhaps into Missouri In fact, the earliest known and best examples of old soils, peats, and forest beds of Aftonian age are found toward the southern edge of the state and, further, the type locality of the horizon is in Union County, which is next to the southernmost tier of counties in the state

At present, of course, the forest cover of the state is very slight, and much of it is secondary Even the bogs and swamps are unique in the almost total absence of trees and shrubs Of the characteristic

inhabitants of boreal bogs during the Aftonian *none* is still found in Iowa The principal coniferous species of the state now are the highly localized *Abies balsamea*, which grows on cold, wet limestone in the unglaciated northeast corner (Pammel, 1907, Conard, 1938), *Pinus Strobus*, in small and isolated areas, *Juniperus communis*, *J virginiana*, and *Taxus canadensis*, all of which have a more southern range than the species found in Aftonian deposits It is rather surprising that the tamarack should be completely lacking in Iowa (Pammel, 1907)

CONCLUSIONS

It is only fair to remark here that there are several criticisms which may be brought to bear on the thesis that the plant remains of the Aftonian deposits present positive evidence that the climate of the interval was boreal

In the first place, it is evident that topography has a very considerable influence on vegetation, and particularly on the distribution of bogs The surface of the Kansan drift has been exposed to the elements for an enormous length of time, during which several glacial and interglacial stages have elapsed As a result, the area in which the Kansan drift is exposed has a well-developed drainage system The same thing is true of the surface of the Iowan drift and loess, but to a somewhat lesser extent, since they are more recent It is only within the areas in Iowa which were covered by an ice sheet during the Wisconsin glaciation that one finds a really youthful topography, with its characteristic lack of drainage, which results in numerous lakes and ponds Even so, bogs are limited to the margins of the Wisconsin drift, where, because of the moraines, the topography is more irregular Beyer (1909), in his discussion of the distribution of the peat bogs throughout the state, says "   all the peat bogs of commercial importance are confined to the Wisconsin drift sheet The deepest bogs tested are in those morainal tracts where the surface is most broken Away from the morainal belt the basins become shallower and the peat thinner, and as a general rule poorer in quality "

Thus it might be said that the lack of boreal mosses and forests may be caused by the lack of suitable habitats It would be a much more valid argument if the deep bogs in the moraines of Wisconsin drift in the northern part of Iowa had such a flora But since they

do not and since the typical boreal bogs of northern Minnesota, Wisconsin, and Michigan are also on the surface of the Wisconsin drift sheet, it would appear that climate, or perhaps only some single factor such as temperature or rainfall, is the deciding point, rather than topography It is probable that earlier in postglacial times boreal species existed in the bogs of Iowa, but have since disappeared as the climate ameliorated with the gradual withdrawal of the Wisconsin ice sheet, which took a good many thousand years (Antevs, 1928) The obsolete, filled-in bogs on the weathered surface of the ancient Kansan drift sheet are an interesting subject for research Their stratigraphical and biological make-up could be investigated without difficulty by means of borings Although, strictly speaking, these bogs might be considered postglacial, in a temporal sense they are interglacial, and are so considered by the European glaciologists Such obsolete interglacial bogs have been carefully studied in Jutland and in northern Germany (Jessen and Milthers, 1928) and the advance and regression of the different floras during two glacial epochs clearly demonstrated A study of the superficial interglacial bogs of Iowa, with their records of plant and animal inhabitation, might provide some interesting and illuminating data on the question of climates during the different interglacial stages in North America

In the second place, it might be argued that the boreal bogs of the Aftonian were simply boreal islands in a warm temperate climate, as the isolated tamarack and spruce bogs of southern Wisconsin, Minnesota, and Michigan are frequently considered today This argument may be refuted in three ways (1) the genuinely boreal nature of many of the Aftonian species of mosses, which do not now live in the southernmost coniferous bogs, (2) the lack of remains of a really temperate flora, which would certainly have been blown or washed into the bogs, if present, and (3) the enormous areal extent of the Aftonian deposits

In the third place, the objection might be raised that the boreal species reported from the Aftonian are from the beginning or the end of that epoch, when, as is perfectly obvious, a boreal type of climate must have prevailed, or even an Arctic type in the vicinity of the ice front The forest beds, with the roots and stumps still in place, which have often been described from the Aftonian deposits, most certainly represent the very end of that interglacial interval,

when the Kansan ice sheet spread its load of débris over the remains of the old forest. In general, however, the plant remains known from the Aftonian so far are to a surprising degree those of distinctly boreal species. Below the forest bed are often other layers of muck and peat which likewise contain traces of plants. Sometimes many feet of exposed fossiliferous strata rest at the bottom on Nebraskan drift and are covered at the top by Kansan till, thus apparently representing a record of a large part of the interglacial period. Yet from such deposits no species of deciduous trees of a true southern nature have been reported. The most temperate type of vegetation was apparently the pine forests, at least, fragments of pine wood have been found in the deeper strata. That traces of more southern types would have persisted, if they had originally been present, is shown by the occurrence of such material in deposits from the second or Yarmouth interglacial interval, after the Kansan glaciation.

In conclusion, it seems to me beyond doubt that the climate of the part of the Aftonian interglacial interval whose deposits have so far been found was much colder and more humid than the present climate of Iowa. Positive evidence of this difference is given by the abundant remains of boreal mosses. To judge from a rough average of the present geographical ranges of the species of plants and animals which have persisted from Aftonian times, the climate of that stage must have approximated the climate which now prevails in the same longitude between five hundred and a thousand miles farther north.

SUMMARY

1. Earlier reports and records of fossil bryophytes, especially those concerned with Pleistocene material, are reviewed.

2. The remarkably fine preservation which has been reported for Aftonian moss specimens is corroborated and illustrated.

3. An annotated list is given of the thirty-three species of mosses (in nearly twenty genera) which have been recognized and named in a large collection of Aftonian material.

4. Four species were so distinct from the most nearly related modern species that they are here proposed as new.

5. Evidence is presented to show that some genera, especially Calliergon and Drepanocladus, were probably more closely related during Aftonian times than they are at present, through a now extinct series of intermediate forms.

6 The absence of many species, which, on the basis of present distribution and association of species, should have been found in this material, is correlated with the chemical composition of the cell walls of the missing species

7 The great importance of fossil mosses as indicators of the climatic conditions under which they lived is pointed out and their use in climatic studies of the past suggested, since in Pleistocene deposits there are often more species of mosses than of any other group of plants

8 The temperate and subboreal nature of the modern moss flora of Iowa is contrasted with the boreal and sub-Arctic species of Aftonian times

9 It is finally concluded that the Aftonian interglacial stage, so far as can be judged by the abundant moss material which has been discovered in its deposits, was much colder and wetter than at present, with a climate like that now existing five hundred to a thousand miles farther north

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EXPLANATION OF PLATE I

FIG 1 *Fissidens sp* The entire fragment, which shows the characteristic distichous leaf arrangement × 25

FIG 2 *F sp* Detail of part of stem shown in Figure 1 × 77

FIGS 3–4 *Dicranum Bergeri* Bland Upper part of two leaves, showing the typical short cells and the costa ending below the apex × 77

FIG 5 *D Bergeri* Bland Profile view of two leaves The serration of the dorsal side of the costa is well shown × 77

FIG 6 *Aulacomnium palustre* (Web & Mohr) Schwaegr Upper part of leaf × 77

FIG 7 *A palustre* (Web & Mohr) Schwaegr Detail of same leaf, showing the thick-walled unipapillose cells × 332

Pleistocene mosses

EXPLANATION OF PLATE II

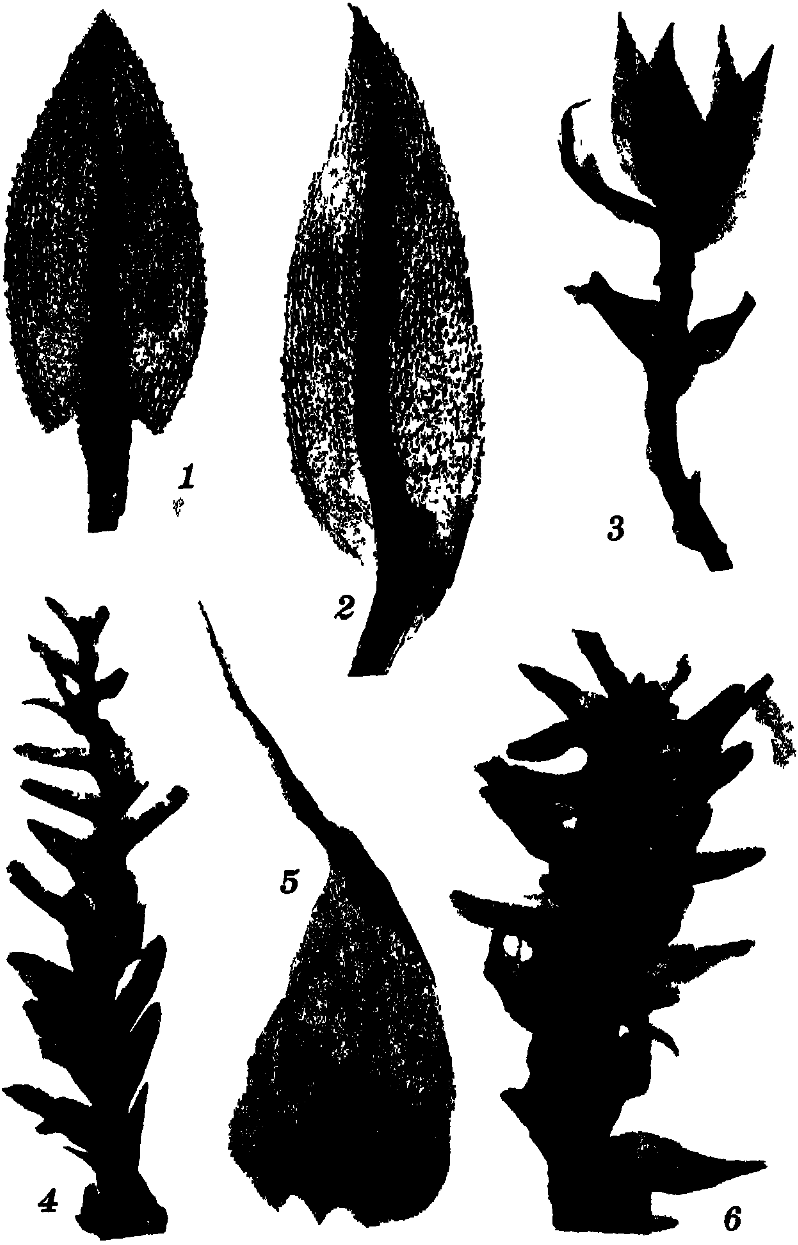
Figs. 1–2. *Philonotis sp.* Single leaves. × 77.

Fig. 3. *P. sp.* Habit of whole specimen, from which several leaves have been removed. × 20.

Fig. 4. *Anomodon attenuatus* (Hedw.) Hüben. Characteristic attenuate branch. × 25.

Fig. 5. *Campylium stellatum* (Hedw.) Lange & Jens. A singe typical leaf with conspicuous quadrate alar cells. × 77.

Fig. 6. *A. attenuatus* (Hedw.) Hüben. Fragment of main stem, showing more detail of leaf shape than Figure 4. × 25.



Pleistocene mosses

EXPLANATION OF PLATE III

FIG. 1. *Calliergon aftonianum*, sp. nov. Single branch leaf. The leaf shape and the short costa are characteristic. × 77

FIG. 2. *C. aftonianum*, sp. nov. Leaves with very short costa from base of a branch. × 60

FIG. 3. *C. Hansenae*, sp. nov. Habit of plant. × 20

FIG. 4. *C. Hansenae*, sp. nov. Apex of plant in Figure 3, showing in greater detail the stem apex, the leaf shape, and the short costa. × 77

FIG. 5. *C. Hansenae*, sp. nov. Basal angle of leaf, showing the elongated, *Drepanocladus*-like alar cells. × 332

Pleistocene mosses

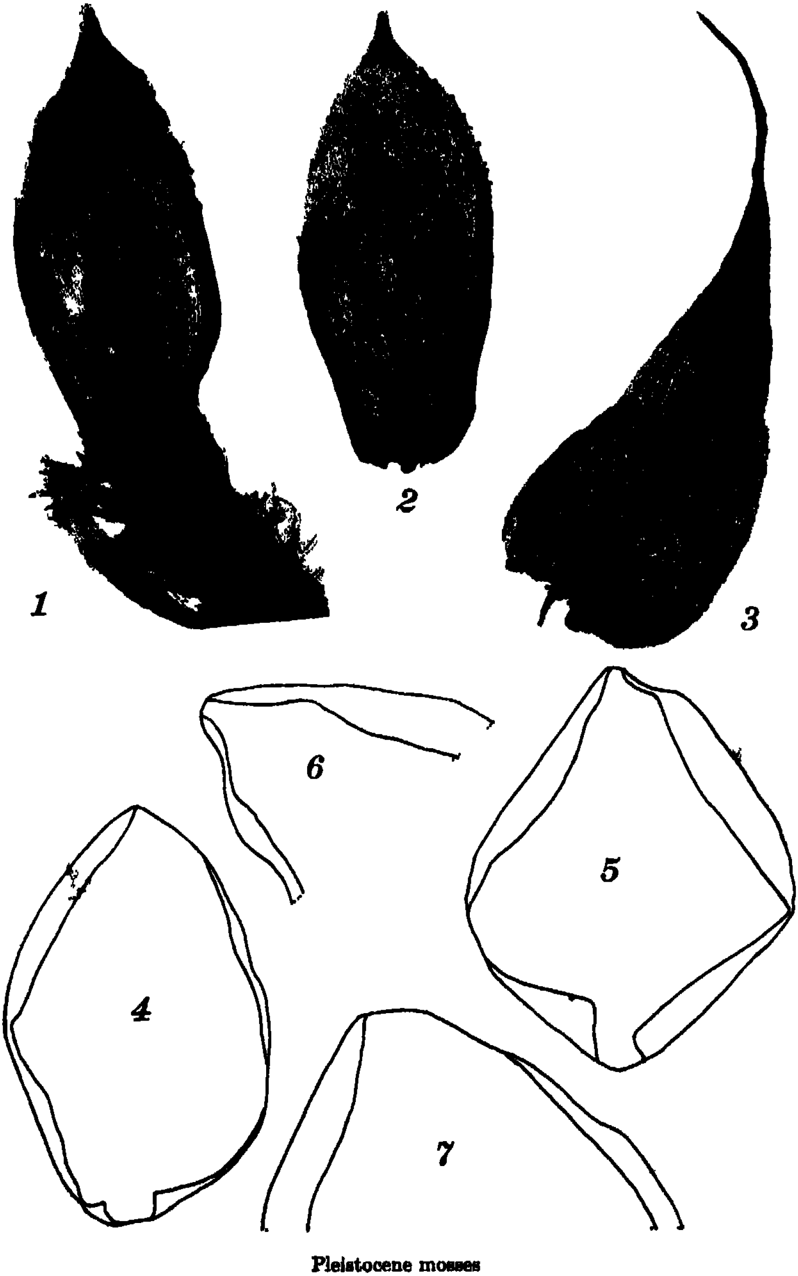
EXPLANATION OF PLATE IV

FIGS 1–2 *Hylocomium splendens* (Hedw) Bry Eur Leaves, showing the typical double costa and the paraphyllia × 77

FIG 3 *Campylium stellatum* (Hedw) Lange & C Jens A single leaf × 77

FIGS 4–5 *Calliergon Kayanum*, sp nov Whole leaves × 24

FIGS 6–7 *C Kayanum*, sp nov Apex of two leaves × 40



Pleistocene mosses

EXPLANATION OF PLATE V

FIG. 1. *Thuidium delicatulum* (Hedw.) Mitt. Apex of ultimate branch showing the well-preserved papillae on the leaf cells. × 332.

FIG. 2. *T. delicatulum* (Hedw.) Mitt. Habit of branch. × 20.

FIGS. 3–4. *Drepanocladus apiculatus*, sp. nov. Characteristic apiculus from two leaves. × 332.

FIG. 5. *D. apiculatus*, sp. nov. Whole leaf, showing the costa, the undifferentiated alar cells, the apiculus, and the fungous hyphae. × 77.

FIG. 6. *Calliergon giganteum* (Schimp.) Kindb. Alar cells and well-developed costa of branch leaves. × 77.

Pleistocene mosses

STUDIES ON CHINESE SPECIES OF GRIFFITHSIA *

CHENG KWEI TSENG

PLANTS of the genus Griffithsia (Ceramiaceae, Rhodophyceae), now credited with a few more than thirty species, are chiefly inhabitants of the warmer seas, although some of them may extend into the temperate zones As early as 1836 Burnett (Murray and others, 1836, pp 329, 332) mentioned the occurrence of "*Griffithsia corallina*" (?) in China, without giving the exact locality The record, like most of the early ones vaguely ascribed to China, is certainly not reliable In fact, the occurrence of true *G corallina* (Lightf) C Ag in the Pacific Ocean does not seem very probable, to judge from our present knowledge of its distribution Since the determination of species of this genus now requires detailed microscopic examination of the reproductive organs, Burnett's record cannot be accepted until the specimen upon which it is based is reëxamined and its identification confirmed In the regions near the China Sea there have been definitely reported three species [1] from the Malay Archipelago (Weber–van Bosse, 1923) and five [2] from Japan (Okamura, 1930a, 1930b, 1933, Yendo, 1914)

In the past few years the writer has collected fourteen different sets of specimens belonging to this genus A study of them reveals the presence of five species, one of which has to be proposed as new All are here added to the floristic list of China for the first time The species can be distinguished from one another by the following analytic key.

* Papers from the Department of Botany of the University of Michigan, No 781

[1] There is also reported a "*Griffithsia sp* " which resembles, according to its author, *G opuntioides*

[2] Yamada (1928) also reported a doubtful record of *G corallina* Okamura, in his *Nippon-kaisōsi* (1936, in Japanese), proposed a new species under the name *G Tomo-Yamadai*, described in Japanese only

A Cells generally cylindrical to subcylindrical and clavate
  B Branching scanty, generally lateral, arising from the proximal end, near the basal walls of the cells 1 *G tenuis*
  B Branching abundant, apparently dichotomous or subdichotomous, arising from the distal ends of the cells
    C Frond bushlike, larger, to 10 cm high, cells generally 4–12 diameters long 2 *G subcylindrica*
    C Frond flabellate, smaller, to 4 cm high, cells generally 2–4 diameters long 3 *G japonica*
A Cells barrel-shaped to spherical, at least the upper ones very distinctly constricted
  B Frond fastigiate, flabellate, branches to 450 μ broad, young branches convergent-furcate 4 *G rhizophora*
  B Frond not fastigiate and flabellate, branches to 1,200 μ broad, young branches not convergent-furcate 5 *G Metcalfii*

1. *Griffithsia tenuis* C. Ag.

(Figure 1)

C Agardh, Species algarum, II, 1828, p 131, J G Agardh, Epicrisis, 1876, p 70, De Toni, Sylloge algarum, IV (3), 1903, p 1284, Collins and Hervey, Algae of Bermuda, 1917, p 135, pl 6, figs 38–39, Børgesen, Marine Algae of the Danish West Indies, II, 1920, p 462, fig 423, Okamura, Icones of Japanese Algae, VI (1), 1933, p 2, pl 302, figs 1–6

Griffithsia thyrsigera Askenasy, Algae, *in* Forschungsreise S M S "Gazelle," 1888, p 36, pl 9, figs 1, 4

The filamentous frond forms loose tufts to 5 cm long It is attached to the substratum by means of vigorous unicellular rhizoids issuing from the decumbent filaments The branching, which is rather scarce and irregular, is predominantly subsecund It has already been pointed out by various authors that the branches arise in a very peculiar way, they originate from the proximal ends of the mother cells near the basal walls (Fig 1) rather than from the distal ends, as in other members of this genus By this characteristic alone it can readily be distinguished from other species, even those in the sterile condition The cells are generally cylindrical, sometimes being a little thicker at both ends They are about 100–180 μ in diameter and 4–6 times as long Deciduous dichotomous hairs are found around the upper ends of the younger cells Tetrasporangia are spherical, tetrahedrally divided, and about 80 μ in diameter when mature No involucral cells accompany them, although there are generally hairs or hair scars below them Eight to twelve of these sporangia form a ring around the upper ends of the fertile cells, which are 3–4 cells below the tip. Two to three whorls in succession are borne by each filament Each sporangium occurs on a unicellular

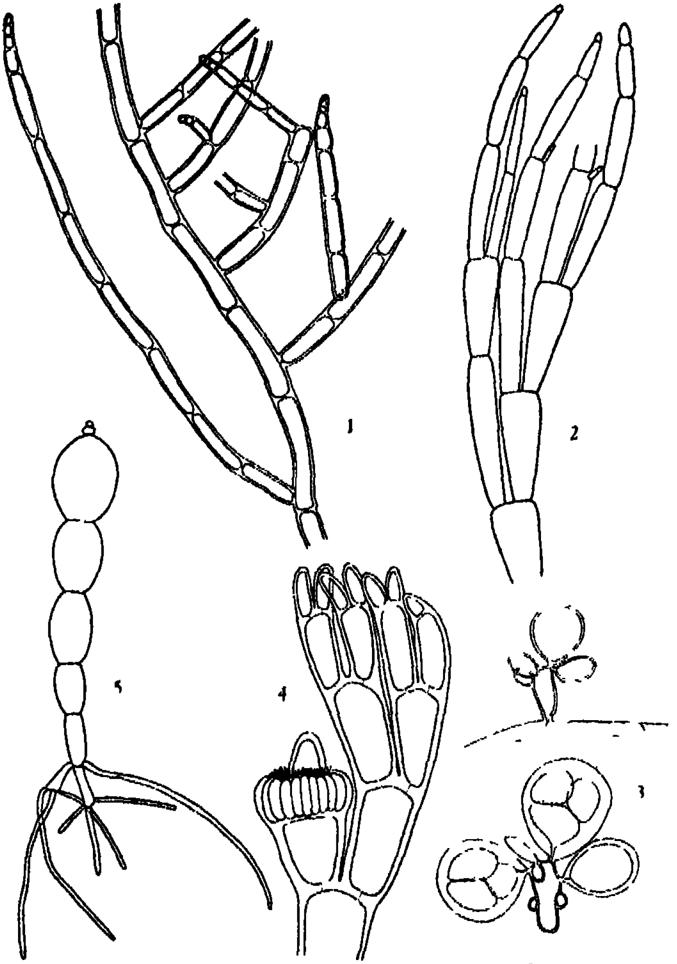


Fig 1 *Griffithsia tenuis* C Ag, showing branching × 16 9

Fig 2 *Griffithsia subcylindrica* Okam Upper part of a branch × 16 9

Fig 3 *Griffithsia subcylindrica* Okam Two groups of tetrasporangia × 211 5

Fig 4 *Griffithsia japonica* Okam. Upper part of a spermatangial plant, showing branching and spermatangial clusters with involucre × 25 4

Fig. 5 *Griffithsia Metcalfii* Tseng, sp nov A young plant × 10 6

clavate or pyriform pedicel, 30–40 μ in diameter and 1 5–2 0 diameters long Neither male nor female plants are found The plant is dark purplish red, and adheres to paper upon drying

Habitat[3] — On sand-covered rocks, at edges of rock pools in the littoral region, Tungshan Island, Fukien, in June (*Tseng 1393*), Hainan Island Yingkehai, in April-May (*Tseng 971*) and February (*Tseng 2369*), Bakloi, in May (*Tseng 1034*), and West Island, Sama, in January (*Tseng 2351*)

Distribution — Widely distributed in warmer and tropical seas

2 *Griffithsia subcylindrica* Okam

(Figures 2–3)

Okamura, On the Algae from the Island Hatidyo, 1930, p 99, pl 8

Plants of this species form dense caespitose tufts to 10 cm high They are attached to the substratum by means of unicellular rhizoids emitted by the basal cells The branching is subdichotomous and fastigiate-erect with very narrow angles (Fig 2) The cells are subcylindrical to clavate, about 400 μ in diameter and 4–12 times as long Tetrasporangia are spherical, being about 80–85 μ in diameter when mature, and are in groups of 3–6, each group with a common pedicel (Fig 3) These pedicels arise verticillately on the upper ends of fertile cells The tetrasporangial groups are involucrate with simple short, incurved cells which originate directly from the articulations Sexual individuals are not found The plant is brilliantly purplish red when living and firmly adheres to paper on drying

Habitat — On rocks in the upper sublittoral region and exposed to strong currents, Yingkehai, Hainan, in February (*Tseng 2379*) and April-May (*Tseng 884, 937*)

Distribution — Hatidyo, Japan

3 *Griffithsia japonica* Okam

(Figure 4)

Okamura, Icones of Japanese Algae, VI (4), 1930, p 28, pl 270

Plants of this species form erect tufts epiphytic on algae and hydroids They are subdichotomous, fastigiate-erect and flabellate, with the upper branches very closely applied to one another (Fig 4)

[3] For the different regions on the China coast see Tseng, 1936, pl VI

Attached to the substratum by basal rhizoids, they sometimes also develop lateral rhizoids, which issue from the upper parts of the frond The cells are subcylindrical below and subcylindrical to strongly clavate above They reach a maximum diameter of 520 μ in the broadened upper portions of the cells, generally, however, they are 300–400 μ in diameter and 2–3 times as long above and 3–4 times as long below Only spermatangial plants have been collected at Amoy Spermatangia are densely clustered in whorls around the upper ends of the fertile cells, generally the subterminal ones They are surrounded by an involucre composed of sixteen or more incurved subcylindrical cells, about 100 μ in diameter and 2–3 times as long (Fig 4) The terminal cell above the spermatangia often drops off, and the spermatangial clusters seemingly terminate the branchlets The plant is purplish red and adheres firmly to paper on drying

Habitat — On algae and hydroids in the lower littoral region, Kukwang, Quimoy, Amoy, in August (*Tseng 2063*)

Distribution — Kyushu to Matsushima, Japan

Although the writer has only the spermatangial plant on hand, he does not hesitate to refer his plant to the Japanese species According to Okamura, the author of the species, it is so closely related to the European *G Schousboei* Mont that he himself is very uncertain whether or not it is distinct from that species, and it seems that Okamura (*loc cit*, p 29) proposed the species on a distributional basis rather than on morphological characteristics "Considering, on the one hand, that the present plant is in far remote waters from the type locality, and on the other, that I could not find any paper reporting the occurrence of *G Schousboei* or its variety in the Pacific Ocean, as far as I am aware, I think better to take the present plant as a distinct species If not a new species, a variety?"

If this is the actual reason, no one would be justified in describing the plant in question as new! Fortunately, *G japonica* Okam appears to be a very characteristic plant, at least according to the writer's interpretation of it It is distinct enough from *G Schousboei* Mont, which is thicker (to 1 mm in diameter), nonflabellate, with broader angles in the upper dichotomies, and has its upper cells typically oval to globular, like *G corallinoides* (L) Batt (= *G corallina* (Lightf) C Ag) The development of tetrasporangial involucral cells on normal branches in some plants of the present spe-

cies seems not to be met with in the European species, Okamura has brought out this difference also The writer is thus inclined to interpret the present species as rather remotely related to *G Schousboei* Mont On the other hand, it seems to be far more closely related to *G opuntioides* J Ag, which, however, has cells much longer (4–6 diameters long), somewhat smaller and less clavate, and branches not so closely applied to one another

Okamura, *loc cit*, quoted Yendo's record (1914, p 277) of *G Schousboei* Mont as referring to the present species Since Okamura may have an entirely different conception of *G Schousboei* and since the writer has not seen the plant on which Yendo based his report of *G Schousboei*, the authentic specimen of which he claims to have seen, Okamura's interpretation of Yendo's record will not be followed for the time being

4 *Griffithsia rhizophora* Weber-van Bosse

Weber van Bosse, Liste des algues du Siboga, III, 1923, p 313

This species has a tufted frond to 2 5 cm high, which is subdichotomous, fastigiate, and flabellate The branching is quite profuse; young branches are characteristically furcate and convergent, like members of the genus Ceramium Cells reach a maximum diameter of 450 μ They are subspherical to ellipsoidal, 1–2 diameters long above and cylindrical, elongated 2–5 diameters farther down The few specimens collected are all sterile

Habitat — In rock pool at lower littoral region, Yingkehai, Hainan, in February (*Tseng 2410*)

Distribution — Ceylon, Malay Archipelago

The vegetative condition of this plant resembles so much the alga from Malay and Ceylon, as described in detail by Weber-van Bosse, that the writer feels justified in classifying it here He was at first inclined to treat it as a sterile environmental form of the next species, which is described as new Since these plants were collected in similar habitats, at the same time, and in the same locality, the environmental factors cannot account for the differences The writer has also found *G Metcalfii*, sp nov, in various stages of development, but has seen nothing similar to this Moreover, the profuseness and the regularity of the subdichotomous, fastigiate, flabellate branches of this species do not occur in the new species

The plants collected are sterile, however, and the writer has not been able to study authentic specimens of the Ceylon-Malayan plant [4] Consequently the determination must be tentative

5 **Griffithsia Metcalfii,**[5] sp. nov

(Figures 5–9)

Frons parva, caespitosa, ca 2 5 cm alta, bene moniliformis, ramosa irregulariter in lateribus vel subdichotome, cellulis sphaericis vel subsphaericis vel ellipsoidalibus in parte superiore majoreque, ad 1 2 mm latis, 1 0–1 5-plo longis, in parte inferiore ad basim frondum vel ramorum saepe subcylindricis, multo angustioribus sed longioribus, ad 400 μ latis, 1 5–3 0-plo longis, penicilli numerosi ad apicem cellularum superiorum, sporangia sphaerica, tetrahedraliter divisa, ca 80 μ lata, circa apicem cellularum fertilium verticillata, solitaria vel 2–3-aggregata in pedicellis brevibus, cellulis involucralibus 1–2 incurvis praedita, ca 80 μ latis, vulgo 3-plo longis, spermatangia ad apicem cellularum fertilium aggregata, haud terminalia, plerumque 2–5 cellis ab apice remota, nuda, sine involucro, cystocarpia lateralia ad apicem cellarum fertilium, protecta 5–6 cellulis incurvis involucralibus, ca 100–200 μ latis, 3–4-plo longis, carposporae pyriformes ca 30 μ latae, 40 μ longa

Specimen typicum Yingkehai, Hainan, May 1, 1934, *Tseng 938*, in herb C K Tseng

This plant forms small tufts to 2 5 cm high The frond as a whole is very strongly moniliform throughout (Figs 5, 9) It is rather irregularly and sparingly branched, the branching being lateral or subdichotomous The attachment to the substratum is generally effected by means of basal rhizoidal filaments (Fig 5) Lateral rhizoids usually issue from the decumbent cells, helping with the anchorage Branches of the same frond sometimes attach to each other by means of short unicellular tenacular cells, and the frond

[4] Ferguson's Ceylon Algae No 316, on which *G rhizophora* Weber–van Bosse was based, as well as Mme Weber's Siboga specimens of this species, are not available in this country Search for it has been made in vain in the herbaria of the New York Botanical Garden and the University of California and in the Farlow Herbarium, which are well known for the richness of their algal collections

[5] This species is named after Professor F P Metcalf, curator of the herbarium of Lingnan University, Canton, China, by whose help the writer was enabled to carry out his first and second trips (in 1933 and 1934) to the floristically interesting island of Hainan, where this and many other new and rare plants were collected

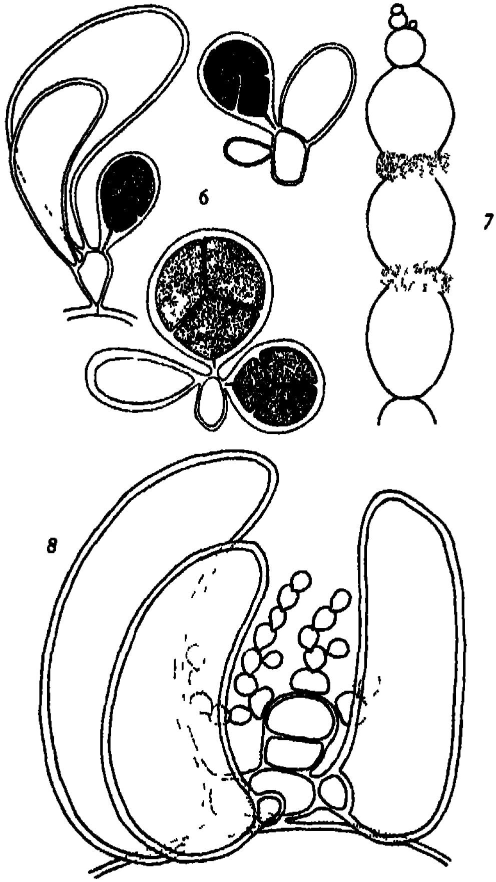


Fig 6 *Griffithsia Metcalfii* Tseng, sp nov Three groups of tetrasporangia, showing different stages of development of sporangia and involucral cells × 219

Fig 7 *Griffithsia Metcalfii* Tseng, sp nov Upper part of a spermatangial branch, showing spermatangial clusters × 17 5

Fig 8 *Griffithsia Metcalfii* Tseng, sp nov A young cystocarp × 127

thus becomes more or less inextricably interwoven below In the major part of the frond the cells are spherical to subspherical, sometimes ellipsoidal, subcylindrical cells are found only at the very base of the branches of the frond The beadlike cells reach a maximum diameter of 1 2 mm, and are usually 1 0–1 5 times as long, the subcylindrical ones are much thinner and longer, as a rule about 400 μ in diameter and 1 5–3 0 times as long The cells are generally

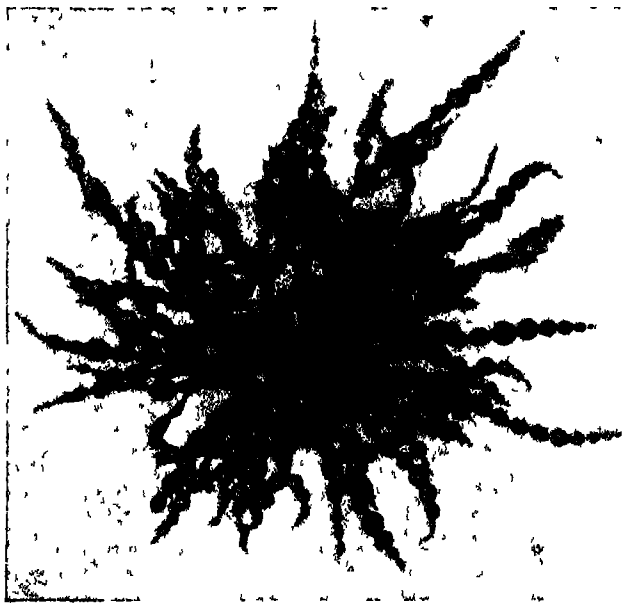


FIG 9 *Griffithsia Metcalfii* Tseng, sp nov Type specimen × 2.8

largest in the middle portion of the frond or somewhat higher, and attenuate toward both apex and base The cell wall is rather heavy, reaching 30 μ in thickness Both young and mature hair clusters are common around the shoulders of the upper cells, they are di- to polychotomously branched, like those of other members of this genus Tetrasporangia are spherical, tetrahedrally divided, to 80 μ in diameter Numerous sporangia form rings around the upper ends of the fertile cells They occur either singly or in twos or threes on short pyriform to subcylindrical pedicels growing out from the

fertile cells Besides the sporangia, each pedicel also gives rise to one or sometimes two incurved, club-shaped involucral cells, about 80 μ in diameter and generally three times as long, which subtend the sporangia within (Fig 6) Spermatangial clusters are not terminal They are found around the upper ends of the fertile cells, which are generally the second to the fifth cells below the apical cell They are naked, without involucre (Fig 7) Cystocarps occur laterally at the upper ends of fertile cells, each protected by 5–6 incurved involucral cells (Fig 8) These are different from the sporangial involucral cells in shape and size, and are much larger below but smaller upward, being about 100–200 μ in diameter and 3–4 times as long In the development of the fertilized carpogonial branch the supporting cell cuts off another, forming the auxiliary cell, as in the case of *G corallina* investigated by Kylin Carpospores when mature are subspherical to pear-shaped and are about 30 μ broad and 40 μ long This plant is rather soft and is light purplish red, it adheres firmly to paper on drying

Habitat — On sand-covered rocks in rock pools in the littoral region, Hainan Yingkehai, in May (*Tseng 938*, TYPE) and in February (*Tseng 2423*), Pê-ngau-kang, Lohwei, in December (*Tseng 1890*)

The present species resembles the Japanese species *G coacta* Okamura (1930a, p 99, pl 9) so closely that the writer was first tempted to identify these specimens with it A strong similarity is found in the emission of lateral root fibers from lower articulations and the occasional presence of tenacula between some filaments of the same frond A more careful study of this species, however, reveals some differences, the most important of which is the presence of involucral cells which are absent in the Japanese plant, as may be clearly seen in the illustrations and description of that species by its author (Okamura, *loc cit*, pl 9, f 9) The absence of involucral cells in the Japanese species is emphasized and used as the characteristic differentiating it from other species, in the key to the Japanese species of Griffithsia in Okamura's manual of Japanese algae (*Nippon-kaisôsi*, 1936, in Japanese) The spermatangia as well as the cystocarps are not described for the Japanese plant and hence comparison of these structures is not possible So far as the described vegetative characteristics are concerned, the Chinese plant seems much more strongly and regularly moniliform and much greater in diameter than the Japanese one Moreover, the present

species is certainly not "dichotomo-fastigiate in upper branches," though that is characteristic of the Japanese plant

Another closely related species is *G rhizophora* Weber-van Bosse, which has also been found in Chinese waters (see p 110) As already indicated in the key and stated in the discussion of that species, the characteristic difference is that the Ceylon-Malayan plant is fastigiate-flabellate, with young branches typically convergent-furcate, whereas the Chinese plant is definitely not so (see Fig 9) *G globulifera* Harv of Atlantic North America and *G corallinoides* (L) Batt of Atlantic Europe are also closely related to the present species They are, however, much more elegant species, with regularly and profusely dichotomous fastigiate branches and generally longer articulations Further, *G globulifera* Harv differs in its capitate spermatangial clusters and the involucral cells of the tetrasporangial ring, which arise directly from the fertile branch cells, but in the present species the spermatangial clusters are not terminal, and the involucral cells originate from the pedicels, which also give rise to the sporangia

f **subsecunda,** f nov

Rami conspicue subsecundi Specimen typicum Seven Stones, Pê-ngau-kang, Hainan, April 26, 1937, *Tseng 2504*, in herb C K Tseng

This form differs from the typical species just described in having predominantly subsecund branching, a more elongated frond, to 6 cm long, and somewhat smaller, but generally longer cells, which are usually more ellipsoidal than spherical Rhizoidal filaments are also much more frequently met with, they issue unilaterally like the branches Plants of this form grow more or less prostrate on sand-covered rocks, whereas those of the typical species grow erect in rock pools, this may account for the vegetative differences found

Habitat — On sand-covered rocks in the littoral region, Seven Stones, Pê-ngau-kang, Hainan, in April (*Tseng 2504*, TYPE)

SUMMARY

To date no Griffithsia has been definitely reported from the China coast, although there is a doubtful record of *G corallina* by Burnett Five species are identified in the writer's collections of this group of plants All these materials come from the South China

coast — from Amoy, Fukien, down to the island of Hainan, Kwangtung One species, *G Metcalfii*, is here described as new, it belongs to the *G corallinoides* (= *G corallina*) group A new form, f *subsecunda*, of this new species, is also described Of the remaining four species one (*G tenuis* C Ag) is widely distributed in warmer waters, another (*G rhizophora* Weber van B) was formerly known to occur only in Ceylon and the Malay Archipelago, the remaining two (*G japonica* Okam and *G subcylindrica* Okam) have hitherto been known only from the southern part of Japan

The writer wishes to express his thanks to Dr Wm Randolph Taylor, professor of botany, the University of Michigan, under whose direction the present study has been carried on

University of Michigan

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CYTOLOGICAL STUDIES ON *SPIRONEMA FRAGRANS* LINDL AND CERTAIN OTHER COMMELINACEAE

SU-HSUEN WU

INTRODUCTION

SPIRALIZATION and the behavior of chromosomes in Tradescantia have been studied in considerable detail by many cytologists (see Kuwada, 1932, 1938, Nebel, 1932a, 1932b, 1933, 1935, Kuwada and Nakamura, 1933, 1934a, 1934b, 1935, Sax and Humphrey, 1934, Nebel and Ruttle, 1935, 1936a, 1936b) Spironema and others of the Commelinaceae, however, seem to have been somewhat neglected, nor has the nucleolus of the Commelinaceae been much discussed The present study deals fully with the structure and behavior of the mitotic and meiotic chromosomes of *Spironema fragrans* Lindl, reports the origin and the development of the nucleolus, and analyzes the relationship between the chromosomes and the nucleolus

This study, undertaken in the Department of Botany, University of Michigan, was conducted under the direction of Professor Wm Randolph Taylor, to whom the writer is greatly indebted for valuable suggestions and helpful criticism She also wishes to express her appreciation to Dr J T Baldwin, Jr, for assisting in revision of the manuscript

MATERIALS AND METHODS

Spironema fragrans Lindl was chosen for detailed analysis because of its large chromosomes and its many rapidly growing roots *Neodonnellia grandiflora* Rose and *Rhoeo discolor* Hance served only as supplementary material *R discolor* has two forms one with leaves which are dark purple beneath and the other with leaves green on both sides The latter was the form investigated

For studying the chromosome number and morphology the permanent root-tip smear method of Warmke (1935), the modified

root-tip smear method of Brown (1937), and the modification of LaCour's root-tip smear method for the Feulgen "nuclear reaction" by Mensinkai (1939a) were tried All yielded satisfactory results, but the last two were superior, for they gave sharper differentiation of the chromatic elements Because of difficulty in obtaining many polar views of metaphase plates in smears, the present study is almost exclusively based on preparations made by the paraffin method, smears were used only for selecting material

It was not easy to secure adequate fixation, especially for the chromosomes between late prophase and anaphase A number of fluids were employed Bouin's, LaCour's 2BE mixture, Navashin's, Flemming's strong solution, Hermann's, and Taylor's modification of Flemming's fluid In general the last three gave the best results Addition of maltose or urea produced little improvement The writer modified the Flemming type of fixative by mixing equal parts of 1 per cent chromic acid and glacial acetic acid, to 5 c c of which were added 2 c c of 2 per cent osmic acid in 1 per cent chromic acid The spiral nature of the chromosomes was exhibited after two hours' fixation with this fluid None of the fluids mentioned, however, revealed clearly the internal structure of mitotic chromosomes at metaphase and anaphase Pretreatment by exposure of root tips to vapors of concentrated HCl or HNO_3 was advantageous for showing this internal structure Proper duration of exposure was determined by experiment With HCl, exposures producing equally good results varied from 30 seconds to 2 minutes, after an exposure of 5 minutes no clear figures could be found HNO_3 required 15 minutes The root tips were washed in distilled water for 30 minutes after the exposure, then fixed with one of the fluids mentioned above Fixation was followed by washing and dehydrating, embedding in paraffin was done in the usual fashion

Sections were cut from 5 to 12 μ in thickness and stained with iron-alum-hematoxylin Newton's gentian-violet method and Smith's modification of this technique gave good results, too, but neither was found to be as practical as hematoxylin The Feulgen stain, prepared after Coleman (1938), who used Norit as a decolorizing agent, was also employed Sections treated in this way afforded excellent differentiation of chromosomes against a colorless background The solution showed no change even after three months Light Green was occasionally used as a counterstain.

For the study of meiotic chromosomes the smear method of Taylor (1924), in conjunction with the fixing fluids mentioned above, was employed exclusively It proved to be the most satisfactory, although the author's modification of Flemming's method was better for demonstrating the doubly coiled nature of the chromosomes

Observations

I SOMATIC DIVISIONS

A *Number and Morphology of the Chromosomes*

1 *Spironema fragrans* Lindl — Darlington (1929), in a study of Tradescantia, described the chromosome morphology of *Spironema fragrans* as two pairs of long chromosomes each with a submedian constriction, one pair with two submedian constrictions, and three pairs with subterminal constrictions, the shortest pair having satellites Anderson and Sax (1936) reported in microspore nuclei of this species two chromosomes with median or submedian constrictions and four with subterminal constrictions In the present material there are six pairs of chromosomes in root tips Chromosomes *aa*, *bb*, and c_1c_2 are large, with submedian constrictions No satellites or secondary constrictions were observed (Pl I, Figs 1–5) The *a* and *b* pairs correspond to the two pairs of long chromosomes in Darlington's description The *c* pair are heteromorphic and correspond to Darlington's third pair of chromosomes, but here no secondary constrictions were observed One of the *c* pair of chromosomes, c_1, has a constriction about one third of the way from one end (Pl I, Figs 1–4) This chromosome is more or less ring-shaped at metaphase At anaphase its two arms straighten out, but the longer arm still bends slightly inward (Pl I, Fig 4) The c_2 chromosome is smaller than c_1 and has a submedian attachment Its two arms are parallel to each other at early metaphase (Pl I, Fig 3) and form a V-shaped chromosome at anaphase, with one arm slightly shorter than the other (Pl I, Fig 4)

Richardson (1934) reported that in one slide of *Spironema fragrans* an extra fragment was found to lie sometimes very close to one of the submedian bivalents Darlington (1929), Koller (1932), and Whitaker (1936) have observed fragments and unequal pairs of chromosomes in Tradescantia Darlington attributed the inequality of these chromosomes to a loss through fragmentation In the

present material there is no direct evidence for fragmentation except in one instance in a preparation pretreated with HCl chromosome c_1 shows a secondary constriction in its longer arm (Pl V, Fig 33a) If dimorphism of the *c* pair of chromosomes was caused by a fragmentation in chromosome c_2, this fragmentation might be expected to have occurred in the region of the secondary constriction Such a secondary constriction was not observed in ordinary preparations, however The abnormality may represent a hybrid character

The *dd*, *ee*, and *ff* pairs are short chromosomes with closely subterminal constrictions (Pl I, Figs 1-4) It is difficult to distinguish among them by size or morphology Careful study shows that one *d* chromosome bears a single satellite at the distal end of the short arm, but this SAT chromosome is not much shorter than the other subterminal chromosome, as was true of the SAT chromosome described by Darlington The other *d* chromosome has two satellites in tandem The distal satellite is usually larger than the proximal one (Pl I, Figs 1, 6, 8), occasionally they are equal in size (Pl I, Fig 7) or the proximal one is larger than the distal (Pl I, Fig 9) If the interpretation of Mensinkai (1939b), that the SAT filament is a continuation of the chromonema and that the satellite is a spiralized end of the chromonema, is valid, it can be applied to explain the difference in size of the tandem satellites as due to the fact that the gyres contract differently in fixation At anaphase, however, the two daughter chromosomes of the tandem SAT chromosome often show the same difference in number of satellites as the *d* pair of chromosomes at metaphase (Pl I, Figs 8-9), i e one daughter chromosome bears one satellite and the other two, in tandem This suggests that one of the satellites may not have split The dissimilarity of the two members of the *d* pair of chromosomes seems to be another piece of evidence for the hybrid nature of the strain of *Spironema fragrans* used in the present work Chromosomes heteromorphic with respect to the presence or the absence of the satellites or in regard to their size have also been observed in Galanthus (Satô, 1937b), in Lobelia (Okuno, 1937), in Allium and Trillium (Mensinkai, 1939a), and in Crocus (Pathak, 1940)

2 *Neodonnellia grandiflora* Rose — This plant appears not to have been previously investigated The chromosomes are comparatively small and numerous in the root tips $2n = 32$ (Pl III, Figs 14-15) Two pairs are slightly submedian in attachment, and the

rest are all subterminal and arbitrarily divisible into three classes according to size three pairs of larger chromosomes, two pairs having terminal satellites on the short arms and the satellites of one pair being smaller than those of the other (Pl II, Figs 10–11), five pairs of medium-sized chromosomes, without satellites, and six pairs of small chromosomes, one pair with terminal satellites on the short arms There are, however, no sharp distinctions between the successive classes The gradation in size from the largest to the smallest chromosomes is apparent in Plate II, Figures 10 11

3 *Rhoeo discolor* Hance — According to Darlington (1929), in the somatic division of *Rhoeo discolor* there are four chromosomes with the short arm less than half the length of the longer one and eight chromosomes submedian in attachment Sax (1935), in a study of the meiotic chromosomes of *R discolor*, stated that six of the twelve chromosomes in the ring are distinctly heterobranchial, but Anderson and Sax (1936) described, in the microspore nuclei, two chromosomes with subterminal fiber-attachment constrictions and four with median ones In the present material three pairs of the chromosomes have more or less median fiber-attachment constrictions, and the other three pairs have the fiber-attachment region at about one third of the distance from one end, with one pair of this latter group bearing satellites (Pl II, Figs 12 13, Pl III, Fig 17) Darlington observed that the two SAT chromosomes are dissimilar and that one chromosome has a second constriction, but this is not true of the material at hand The only dissimilarity observed by the writer is that often one of the medianly constricted chromosomes is somewhat ring-shaped at metaphase, no difference in size or in structure was seen (Pl III, Fig 17) The satellites were not clearly observed in anaphase (Pl III, Fig 18)

B *Chromosome Structure and Behavior in Spironema fragrans*

1 *Prophases* — In early prophase more or less regularly coiled threads evenly distributed throughout the nucleus are observed In most instances the spirals appear as single coils (Pl IV, Fig 22), but occasionally, in the same nucleus, their duality can be seen in certain parts (Pl IV, Fig 23) It later becomes clearly evident that the spirals are double; they are in reality the sister chromatids formed at the last premetaphase Still later the nuclei become much larger, the nucleoli are near the nuclear center instead of being in

the region of the poles, as at telophase, and anastomoses between paired chromatids occur less frequently, if at all The sister chromatids are oriented as at telophase (Pl IV, Fig 24) The matrical material is not evident at this stage, the suggestion being that it contributes to the formation of the nucleoli The coils of the chromatids now stretch considerably, and the double spirals are more clearly and regularly apparent (Pl IV, Fig 25) Next the sister chromatids gradually draw close together (Pl IV, Fig 26), this approximation being accompanied by a general contraction of the chromosome An untwisting and a relaxing of the coils are also noticeable at this stage (Pl IV, Fig 27) Contraction with relaxation of the old spirals is caused by new spirals within them, which bring about an internal twist of the chromatid, the new spirals are not visible until late prophase They may be called "minor spirals," corresponding to the minor spirals observed in meiosis As contraction continues the chromosomes become thicker, and each chromatid assumes a corrugated appearance, which is *the first sign of the minor spirals* Meanwhile the chromatids have untwisted rapidly One can find (Pl IV, Fig 29) a longitudinal splitting throughout each chromatid of one chromosome, while the chromatids of another chromosome exhibit only an untwisting in certain parts In later stages, seldom in early ones, a differentiation of the chromonemata and the achromatic matrix is seen The matrical material gradually increases and, when stained, obscures the duality of the chromatids

2 *Metaphase* — As the nuclear membrane disappears, the individuality of each chromosome is quite apparent, and the chromosomes become aligned at the equatorial plate, their fiber-attachment regions being toward the center of the plate and their arms in the axis of the spindle Relaxation of the relic spirals has been completed, but relational coiling can still be observed at early metaphase (Pl V, Fig 32) In preparations pretreated with HCl or HNO_3 the duality of the chromatids can be clearly seen Each consists of two chromonemata, the metaphase chromosomes are quadripartite (Pl IV, Fig. 30)

Relaxation of relational coils seems caused by the formation of minor spirals In certain parts of the chromosomes, where minor spirals are observed, there are few relational coils, in other parts, where no minor spirals appear, more relational twists remain (Pl IV, Fig 29) This relaxation is completed by the time the minor spirals

reach their full expression The untwisting and the development of the minor coils proceed from the ends of the chromatids toward the primary constriction, as is clearly shown in Plate IV, Figure 29

3 *Anaphases* — Each anaphase chromosome consists of two sister chromatids intertwined (Pl IV, Fig 31, Pl V, Fig 33) At this stage the satellites and their filaments are single (Pl V, Fig 33b) The matrix can be seen clearly at both metaphase and anaphase, but it is usually not uniformly distributed, probably because of variations in the effectiveness of the pretreatment

4 *Telophases* — The chromosomes become massed together as they reach the poles The chromosome structure, though obscured, is the same as at anaphase, as can be seen in the arms of the chromosomes which project from the mass Soon the chromosomes begin to expand in their distal parts, where they have the form of two intertwined spirals (Pl V, Fig 34) At this point, because of their expansion, the individuality of the chromosomes is again apparent, and — in spite of a decrease in stainability — their spiral nature is clearly revealed (Pl V, Fig 35) The karyolymph is differentiated at this stage, and a nuclear membrane is formed about each daughter chromosome group Nucleoli are developed at the proximal ends of certain chromosomes Anastomoses appear between the chromosomes One has the impression that when the chromosomes draw apart from each other after being once closely appressed, interconnections remain In certain parts of the chromosomes there is a single helical spiral, in other parts double spirals are intertwined (Pl V, Figs 35, 39) The chromosomes are prominently oriented at telophase (Pl V, Figs 36–39), a condition which results from the anaphasic arrangement of fiber-attachment regions toward the poles when the arms of the chromosomes are spreading behind This disposition of the chromosomes is kept until prophase

5 *Interphase* — Interphase is characterized by a so-called "reticular" aspect arising from a further expansion of the telophase chromosomes As expansion continues the spirals are much loosened and the dyads become extremely thin At points where anastomoses are drawn out and where two chromatids intertwine thickenings occur, so that the nucleus has a knotted aspect Later these dyad threads get thicker, and the anastomoses are lost This increase in thickness is probably accompanied by contraction of the chromosome as a whole, and the contraction brings the sister chromatids so

close together that they give the appearance of being single spirals, as they do at early prophase

C *The Nucleolus*

Van Camp (1924) considered that the nucleolus arises in telophase from small granules which flow together Marshak (1931) described a close relationship between the chromosome matrix and the nucleolus substance Gates and Pathak (1939) also observed the nucleolus to originate, in Crocus, as small globules, but at a particular region of definite chromosomes Recent investigators (Nandi, 1937, Satô, 1939, Jacob, 1940, and Pathak, 1940) have reported small granules which are present in early telophase chromosomes and which contribute to the formation of the nucleolus These workers, in contradiction to van Camp and Marshak, consider that the small granules aggregate in nucleoli-organizing regions of the SAT chromosomes and form a definite number of nucleoli under the influence of these regions, as described by McClintock (1934)

Heitz (1931a) postulated that all plants have satellites or secondary constrictions from which nucleoli arise The nucleoli are correlated with the satellites in number, size, and position Heitz (1931b) found, however, in *Vicia faba* and *V monanthos*, which have only two SAT chromosomes, instances in which a micronucleus, formed from a single lagging chromosome without a satellite, had a nucleolus This implies that even when the SAT chromosomes are absent nucleoli will arise Matsuura (1938) observed that, whereas in *Paris hexaphylla* the nucleolar development is related to the SAT chromosomes, in *Trillium kamtschaticum*, where there are neither SAT chromosomes nor secondarily constricted chromosomes, the nucleolus nevertheless originates at given ends of certain chromosomes He also reported, in an abnormal individual, that each chromosome formed a micronucleus and developed its own nucleolus Satô (1936a, 1936b, 1937a, 1937b, 1938), basing his opinion on a series of investigations dealing with the relationship of the nucleolus and the SAT chromosome, agreed with Heitz's hypothesis In 1938 he observed, however, that there are two SAT chromosomes in some species of Leucojum and Sternbergia, but four nucleoli in the same plants All the evidence mentioned above shows a tendency to revision of the interpretation assigning the origin of the nucleolus to a particular chromosome pair and to a consideration of it as a func-

tion of the chromosomes as a whole Since all these facts were observed in abnormal individuals, however, most investigators are still in agreement with Heitz's hypothesis

1 *The relation of nucleolus and chromosomes* — There is only one pair of SAT chromosomes in *Spironema fragrans*, but as many as three nucleoli are present at telophase (Pl V, Fig 38) At prophase and metaphase commonly one, very often two, occasionally three, nucleoli are to be seen (Pl IV, Figs 22, 24–27, 29) A striking fact is that, at metaphase, a nucleolus may be attached to a submedianly constricted chromosome without a satellite Similar attachments were frequently found at later stages (Pl VI, Fig 45) The nucleolus is sometimes related to chromosome *a* (Pl VI, Fig 45), at other times to other chromosomes to chromosome *b* (Pl VI, Fig 46) or chromosome c_1 or c_2 (Pl VI, Fig 47), for example The nucleolus is not at a definite locus, though it is always attached to the longer arm of metaphasic chromosomes A relation between the nucleolus and the subterminal chromosomes, including the SAT chromosomes, was observed in different nuclei (Pl VI, Figs 48 49) It seems that any chromosome may produce a nucleolus Often a faintly stained membrane-like structure connects the nucleolus and the chromosomes (Pl VI, Figs 45, 47, 49) Though the nucleolus remains large and clear in metaphase, no nucleolar divisions have been found The nucleolus usually disintegrates in the cytoplasm after detachment from the chromosomes

2 *The origin and behavior of the nucleolus* — Nucleoli usually do not appear before the daughter nuclei are well organized (Pl V, Fig 35) As telophase advances, a nuclear membrane arises, and the chromosomes become arranged at the periphery of the nucleus with the proximal ends of their arms still oriented at the pole Soon a nucleolus appears in the midst of the chromosomes (Pl V, Fig 36) Its relation to the chromosomes can be seen from a polar view or, at least, from an oblique view (Pl V, Figs 36–38) One pair of SAT chromosomes is clearly attached to the nucleolus in the region of the satellites (Pl V, Fig 36) All nonsatellited chromosomes in the same nucleus are, however, also attached to the same nucleolus Two comparatively large nucleoli and two small nucleolus-like granules are connected to the chromosomes with many faintly stained threads (Pl V, Fig 37) These two small granules are considered to be a beginning of nucleolar development, they probably fuse with each

other or with other collections of nucleolar material to form a larger nucleolus There may be three nucleoli in the same nucleus (Pl V, Fig 38), and they may be in direct contact with the chromosomes or else connected with them by fine threads These observations suggest that when the fiber-attachment regions of the chromosomes are regularly arranged and close together one large spherical nucleolus is formed When they are loosely and irregularly arranged two or three nucleoli may be developed at the same time Incipient nuclei usually show the same number of nucleoli (Pl V, Fig 39) The development of a nucleolus seems caused by the gradual addition of nucleolar material arising from the chromosomes (Pl V, Fig 36) or by mutual contact of small collections of nucleolar material (Pl V, Fig 37) If the chromosomes remain at the periphery of the nucleus the fully developed nucleoli become detached from them and move into the center of the nucleus The nucleoli maintain the same position through interphase and early prophase (Pl IV, Fig 24)

At middle prophase, when the chromosomes become thicker, they usually surround the nucleolus (or nucleoli), and are so closely associated that it is difficult to detect which parts are in contact with it This phenomenon is more prominent in *Rhoeo discolor* (Pl IV, Fig 28) These observations indicate a strong affinity between the chromosomes and the nucleolus at this stage, possibly there is then a transfer of material from the nucleolus At later prophase only one or two chromosomes, and these not always the same ones, still remain in contact with the nucleolus The relation of the nucleolus and the chromosomes at prophase is shown in Plate V, Figures 40–41, and Plate VI, Figures 42–44 Chromosomes with both submedian and subterminal constrictions and both satellited and nonsatellited chromosomes were observed to be attached to the same nucleolus (Pl VI, Fig 44), or one homologue was attached to the nucleolus and the other was near by (Pl VI, Fig 43, *right*), or two nonhomologous chromosomes were related to the same nucleolus (Pl VI, Fig 42, *right*) It is interesting to notice that, whatever the arrangement, the prophasic chromosome is always in contact with the nucleolus by the distal end of its short arm The satellited chromosomes attach to the nucleolus by their satellites instead of by the SAT filament (Pl VI, Fig 43, *left*), as observed by Heitz (1931a) and many other investigators Comparison of nucleolus–chromosome relationship at prophase with that at metaphase shows a movement

of the nucleolus from the distal ends of the short arms of the chromosomes to the distal ends of the long arms When the nucleolus migrates from one end of a chromosome to the other, the nucleolar material may be evenly distributed through the whole length of the chromosomes Apparently the membrane-like connection between the nucleolus and the chromosomes is material passing from the nucleolus to the chromosomes Most investigators hold the view that the nucleolus remains firmly attached to its locus of organization, or near it, from the time the nucleolus is organized until its disappearance Seemingly this is not true of the present material

In *Rhoeo discolor* the origin and the behavior of the nucleolus are essentially the same as in *Spironema fragrans* Here, too, there is only one pair of SAT chromosomes The maximum number of nucleoli is four The attachment of the nucleolus to each type of chromosome has been recognized in different nuclei at prophase Three chromosomes with almost median constrictions are attached to nucleoli as shown in Plate VI, Figure 50 In the submedianly constricted chromosomes the nucleolus is usually attached at prophase to the distal end of the short arm, but occasionally to the long arm (Pl VI, Figs 51–52) At metaphase the nucleolus has been found only a few times (Pl VII, Fig 53) Movement of the nucleolus from one end of the chromosome to the other is not shown for this material, but in Plate VII, Figure 53, one can see the nucleolus attached near the middle part of the arm instead of at the end

II MEIOTIC CHROMOSOME STRUCTURE AND BEHAVIOR IN *SPIRONEMA FRAGRANS*

A *First Meiotic Division*

The spiral structure of meiotic chromosomes, observed in 1880 by Baranetzky, has been described in many plants. Kuwada and other Japanese workers, in a series of papers, have described the chromonemata of metaphase chromosomes as "double-coiled" Similar reports have been made by Darlington (1935), for Fritillaria, Sax (1935), for *Rhoeo discolor*, Nebel and Ruttle (1936b), for *Tradescantia reflexa* and *Trillium erectum*, and Naithani (1937), for *Hyacinthus orientalis* Koshy (1934), Hoare (1934), Huskins and Smith (1935), Huskins (1937), and other workers, however, regard the chromonema at this stage as single-coiled.

1 *Diakinesis* — In Spironema, though there are not sufficient preparations for studying earlier stages of meiosis, the double-coiled structure is apparently not present in the leptotene chromosome (Pl VIII, Fig 68) At diakinesis the chromosomes are so compactly twisted, and usually so deeply stained, that it is difficult to analyze the structure in detail (Pl VII, Fig 55) Because of the evidence of later stages the reticular appearance is considered to result from a number of spiraled chromonemata twisted together, and the less-stained substance is thought to be the matrix The chromatids are mutually parallel, with corresponding gyres arranged at the same level, thus producing a regular reticulum As the process advances, some of the chromosomes form bivalent rings (Pl VII, Fig 54 a–c), and others have the two distal parts parallel (Pl VII, Fig 54d) In late diakinesis there are three more or less ring-shaped tetrads and three cross-formed associations (Pl VII, Fig 56) The so-called "kinetochores" or "centromeres" are clearly seen in Plate VII, Figure 56, a pair in each dyad The transition from the stage in Figure 54 to that in Figure 56 must be rapid, for no intermediate forms were observed The internal structure of the chromatids, at the stage shown in Figure 56, gives the appearance of transverse bands embedded in the matrix Under certain conditions of distortion this structure — continuous spirals and longitudinal splitting of each of the chromatids — can be observed more clearly (Pl VIII, Fig 62)

2 *Metaphase* — Some of the chromosomes begin anaphasic movement before the others (Pl VII, Fig 57), and it is difficult to find a complete chromosome set of three rings and three crosses at full metaphase However, three ring-shaped chromosomes from one cell (Pl VIII, Fig 63) and three cross-shaped chromosomes from another are illustrated (Pl VIII, Fig 64) Sax and Humphrey (1934) observed, in Tradescantia, that during metaphase the coiled chromatids of each chromosome gradually separate until each homologue consists of two separately coiled threads In the present material, not only do sister chromatids lie parallel in independent spirals, as described by Kuwada (1938) in *Tradescantia reflexa*, but sister chromonemata are also side by side before metaphase The four chromonemata of each dyad are so arranged that when viewed laterally they appear as two When there is a twisting, however, especially

at the ends of the chromosome arms, the four-strand condition can be clearly seen (Pl VIII, Fig 63 a–b, Pl III, Fig 20 a, f, h)

The metaphase chromosomes have major and minor spirals The major coils gradually increase in diameter as karyokinesis proceeds Coiling appears to be unidirectional on a given side of the spindle attachment The minor spirals are too small to be studied in detail As the two dyads of the rings gradually separate they disjoin first at the distal ends of the short arms and then at the distal ends of the longer arms (Pl III, Fig 20 a–g) One ring-shaped tetrad has two constrictions, one apparently the fiber-attachment constriction, the other subterminal and usually disappearing in later stages (Pl VII, Fig 57) Six submedianly constricted dyad chromosomes are formed from the metaphasic ring tetrads (Pl III, Fig 19, Pl VII, Fig 57) The dyads from each cross-shaped tetrad are rodlike or have almost terminal constrictions (Pl III, Fig 20 h–j) A side view of this stage is shown in Plate VII, Figure 58 The sister chromatids of each dyad separate distally but are still held together at the fiber-attachment region (Pl VII, Fig 59) Each half dyad consists of two double-coiled chromonemata

3 *Anaphases* — The anaphase chromosomes move into mirror-image positions at the poles (Pl VII, Fig 60) During anaphase eight chromonemata in each geminus become discernible (Pl VIII, Fig 65) The major coils are more definite five in the long arms of the chromosomes with submedian constrictions and of those with subterminal ones, three in the short arms of the submedianly constricted chromosomes Generally one or two chromosomes reach the poles before the others (Pl VII, Fig 60)

4 *Telophases and interphase* — During telophase sister chromatids become parallel, and the four chromonemata interconnect, a reticulum arises, and the minor coils of the chromonemata gradually lose their identity (Pl VIII, Fig 66) Individual chromosomes now appear, very much as they did at diakinesis, the chromonemata being arranged in the same manner as they were then (Pl VIII, Fig 69) Later stages exhibit a looser reticulum, involving a multitude of apparently threadlike interconnections between chromosomes (Pl VIII, Fig 67), individual chromosomes remain recognizable The chromosomes gradually become strongly stainable and compact masses (Pl. IX, Fig 70)

B. *Second Meiotic Division*

1 *Prophases* — As prophase of the second meiotic division begins, the chromosomes unravel from the compact masses, this process is accompanied by a progressive loss of stainability They then expand, become more uniform in diameter, and finally spread evenly throughout the nucleus as loosely coiled threads (Pl IX, Fig 71). In later stages it is not impossible to trace each chromosome for its whole length (Pl IX, Fig 72), and all chromosomes in a single nucleus may be analyzed The split chromosomes have threadlike connections at the fiber-attachment region, distal regions diverge Chromosome structure and behavior here are much like those observed by Taylor (1931) in Gasteria In the present material three chromosomes are submedian and three are subterminal, one of the latter bearing a pair of satellites No satellites or subterminal fiber attachments were found in the chromosomes of the first meiotic division, they were probably obscured by the extreme thinness of the chromonemata and the abundant matrical substance

Taylor (1931) found, in Gasteria, that a splitting takes place at late prophase of the second meiotic division In the material studied by the writer the splitting of each of the chromatids was seen to take place at late diakinesis and was traced to the first telophase, where the two pairs of chromonemata in each dyad merge into a reticular structure This four-strand condition reappears optically at late prophase of the second division (Pl IX, Fig 73) Sister chromonemata at this stage are closely twisted about each other instead of being mutually parallel, as they were in the first meiotic division

According to Nebel (1932a), in *Tradescantia reflexa* four chromonemata are evidently dyad chromosomes from the first telophase through the second prophase, where two double spirals are formed for every four chromonemata The gyres of the double spirals correspond initially to those of the first meiotic chromosomes, but soon the two chromonemata of the double spiral are thrown into secondary spirals, which are very small This seems similar to the condition observed in second prophase of the present material, though here the formation of secondary spirals probably takes place earlier They are considered to occur at the end of the first telophase, when the chromosomes draw together and form compact masses As the chromosomes emerge from these masses the two chromonemata

of each half dyad must be so closely entwined that they appear single at early second prophase When the chromosomes contract and thicken, the duality is brought out again With the reappearance of the secondary spirals the old coils gradually straighten (Pl IX, Fig 73) Only a few satellites were found (Pl VIII, Fig 61a, Pl IX, Fig 72)

As the process advances, the chromosomes greatly shorten and thicken and become differentiated into their constituent matrix and chromonemata The number of secondary spirals is much reduced (Pl IX, Fig 74) The half dyads may or may not separate before the nuclear membrane disappears

2 *Metaphase* — As the nuclear membrane vanishes the dyad chromosomes draw close together into apposition and shorten somewhat (Pl III, Fig 21, Pl IX, Fig 75) They lie around the edge of the plate with their fiber-attachment regions toward the center Kuwada and Nakamura (1935), in *Tradescantia reflexa*, observed the chromonemata at this stage to be singly coiled and parallel to each other In the present material, however, they are intertwined, as described by Taylor (1931), Nebel (1932a), and others The chromosomes of this division are essentially like those of a somatic division, though shorter

3 *Anaphases* — Anaphasic movement is assumed to be completed quickly and the daughter chromosomes oriented at the poles (Pl IX, Fig 76) Two polar views of the anaphase group are shown in Plate III, Figure 16 The anaphase chromosomes are usually less thick than the metaphase ones, but structurally they are the same If examined by ordinary methods the internal structure of chromosomes at second metaphase and second anaphase is obscure Their coiled nature and the duality of each half dyad is revealed more clearly by preliminary natural desiccation The double nature of half dyads at second anaphase has also been described by Taylor (1931), in Gasteria, Nebel (1932a), in Tradescantia, Sax (1935), in Rhoeo, and Kuwada and Nakamura (1935), in Tradescantia

4 *Telophases* — The twisted condition of the chromonemata is still visible at telophase (Pl X, Fig 77) The chromosome mass becomes enveloped by a new membrane, the nucleus enlarges, and the chromosomes lengthen greatly (Pl X, Fig 78) The duality of each chromosome becomes clearly evident. As the process goes on, the chromosome outline is gradually lost, and eventually the chro-

matic structure spreads uniformly throughout the nucleus (Pl X, Figs 79–80)

SUMMARY

1 *Spironema fragrans* shows six pairs of somatic chromosomes, of which three pairs are submedian and three pairs subterminal One pair of the subterminal chromosomes bears satellites Two pairs of the chromosomes are considered to be heteromorphic

2 *Neodonnellia grandiflora*, with sixteen pairs of somatic chromosomes, shows two submedian pairs and fourteen subterminal pairs Three pairs of the subterminal chromosomes bear satellites

3 *Rhoeo discolor* appears to have six pairs of somatic chromosomes, with three pairs having an almost median fiber attachment and three pairs having a fiber attachment at one third of the distance from one end

4 The somatic chromosomes in *Spironema fragrans* are double throughout mitosis and become quadruple in premetaphase In meiosis the leptotene threads appear to be double Division of the chromatids takes place in premetaphase of the first meiotic division Each homologous chromosome at first metaphase consists of four chromonemata which appear as four independently double-coiled spirals At anaphase each contains a pair of chromatids which part along their distal ends and hold together only at the fiber-attachment region Each chromatid of the dyad consists of a pair of chromonemata which are parallel to each other, with their corresponding turns arranged at the same level

5 At second meiotic division new spirals are formed which uncoil the relic spirals The second metaphase and anaphase chromosomes are therefore composed of minor spirals only The duality of the second anaphase and telophase chromosomes is clearly visible

6 The behavior and the origin of the nucleoli in somatic telophase were studied in *Spironema fragrans* The nucleolar material is considered to be collected at the fiber-attachment region of each chromosome, and the nucleoli were observed to be accumulated in the midst of, or in the spaces between, the centromeres of the chromosomes The relation between nucleolus and chromosomes was traced at prophase and metaphase in *S fragrans* and *Rhoeo discolor* The nucleoli are not particularly attached to the SAT chromosomes or to any certain chromosomes The chromosomes were seen to have equal

chances of forming nucleoli at telophase, and likewise to have an equal chance of being attached to the nucleolus at prophase and metaphase A migration of the nucleolus from the distal end of the short arm of the chromosome to that of the longer arm, as the mitotic process advances from prophase to metaphase, was observed in *S fragrans* It is believed that the nucleolar substance contributes to the matrix of the chromosomes

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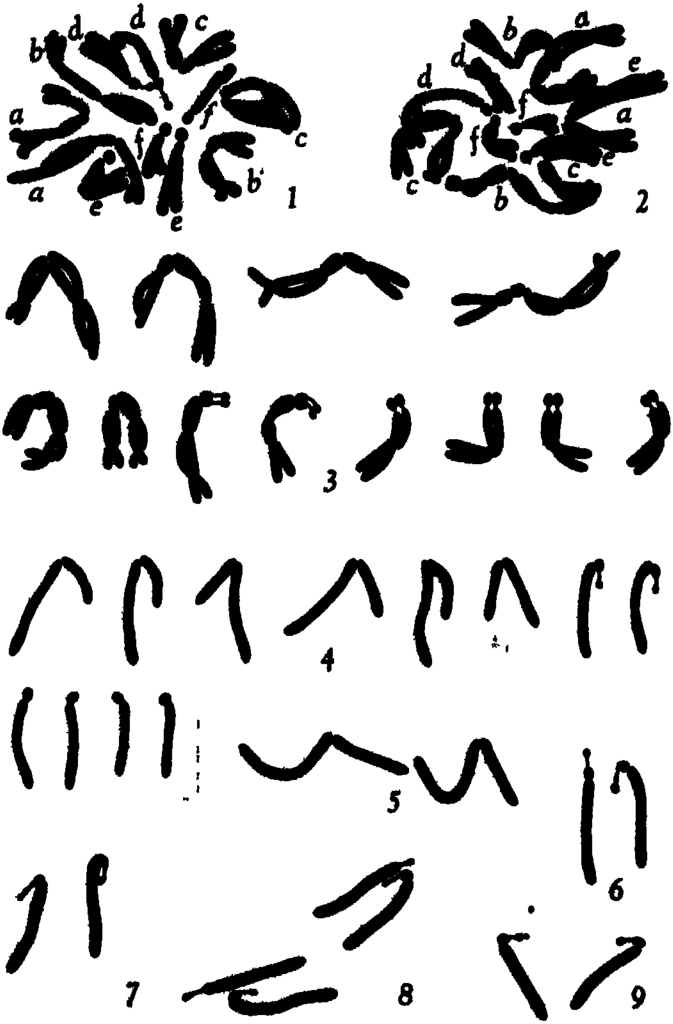
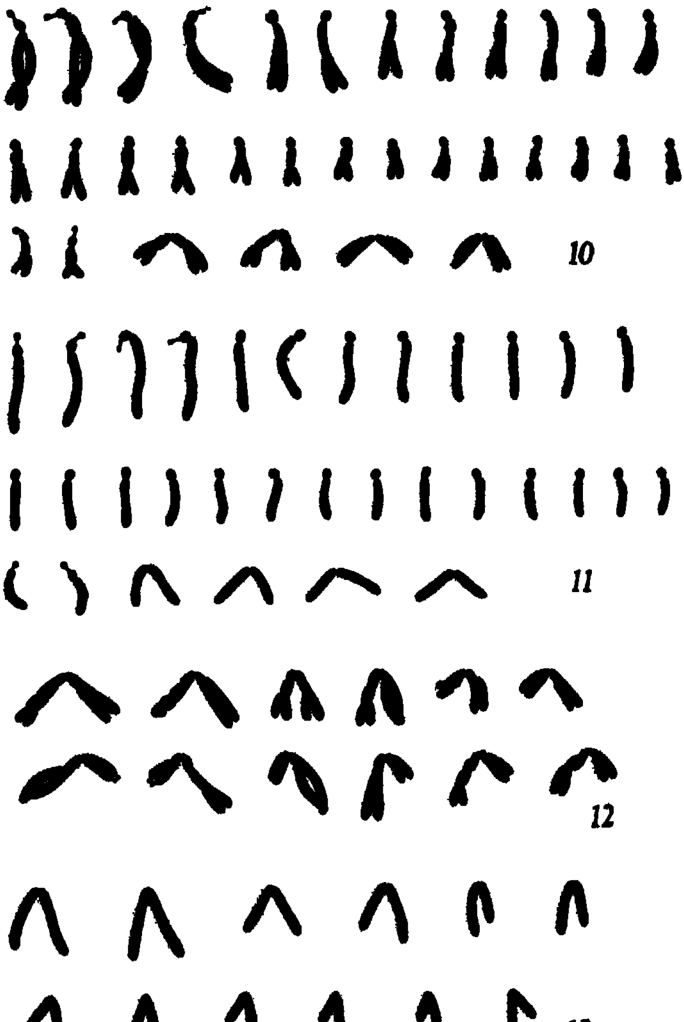
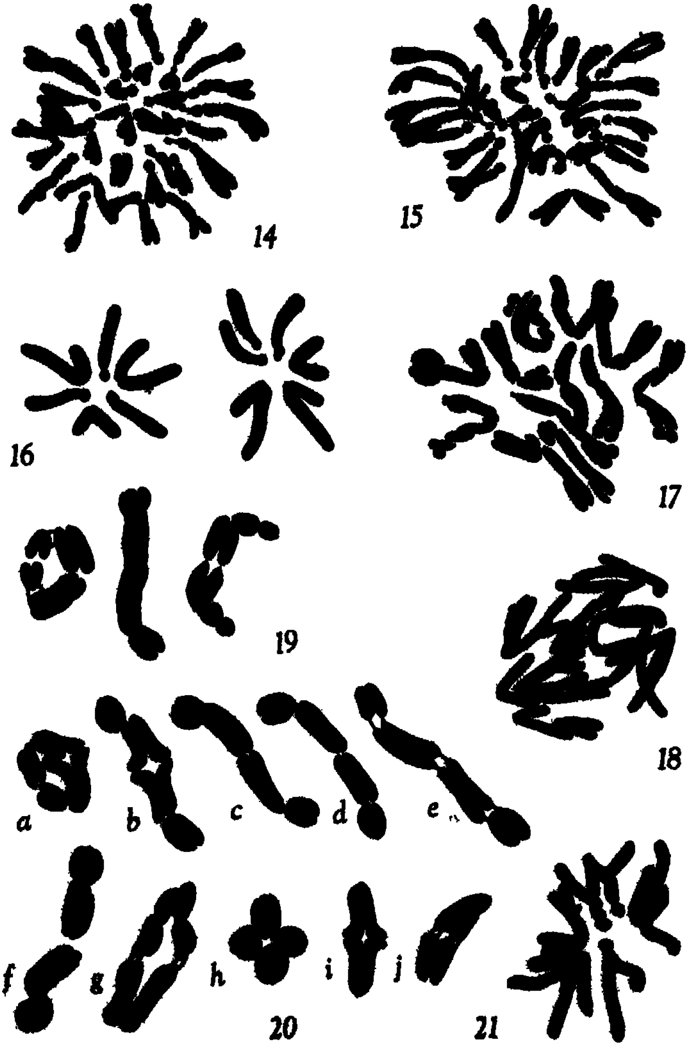
PLATES I–X



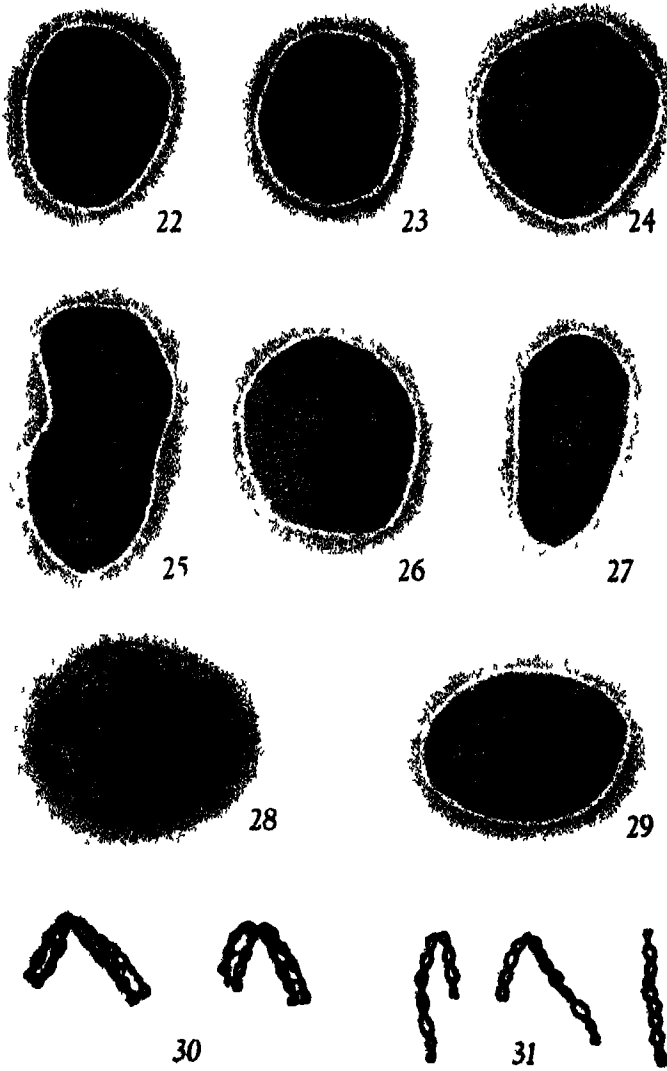
FIGS 1–9 Chromosomes of *Spironema fragrans.* × 2000



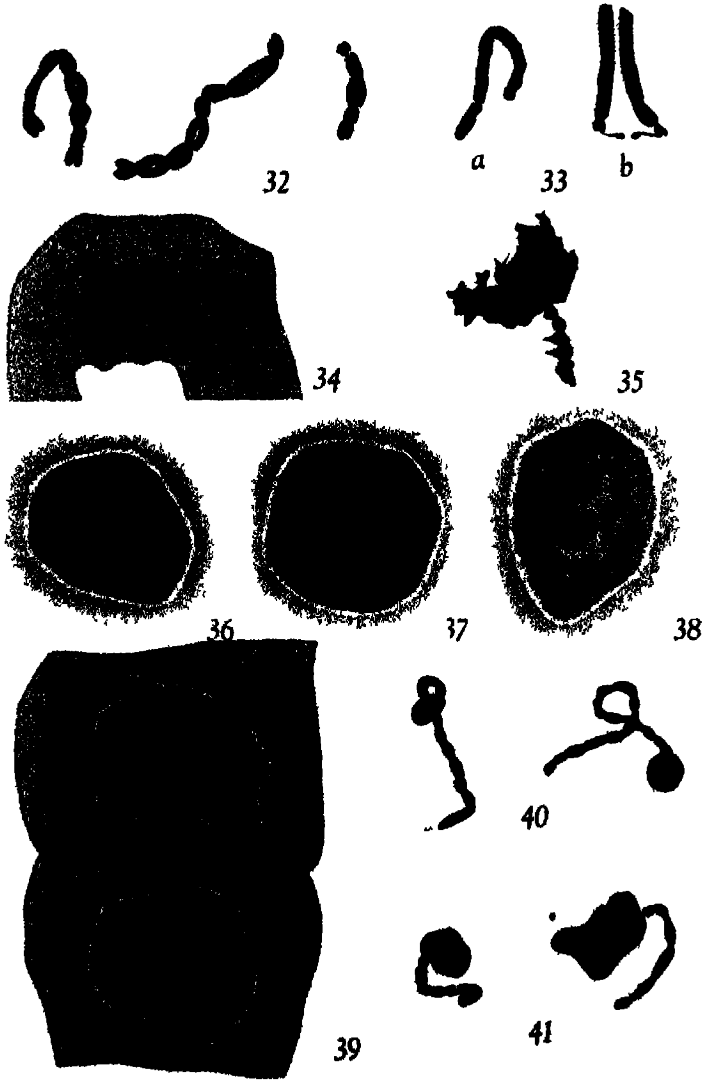
FIGS. 10–13. Chromosomes of *Neodonnellia grandiflora* (Figs. 10–11) and *Rhoeo discolor* (Figs 12–13). × 2000



FIGS. 14–21 Chromosomes of *Neodonnellia grandiflora* (Figs 14–15), *Rhoeo discolor* (Figs. 17–18), and *Spironema fragrans* (Figs 16, 19–21). × 2000 except Figure 17 (× 1600)

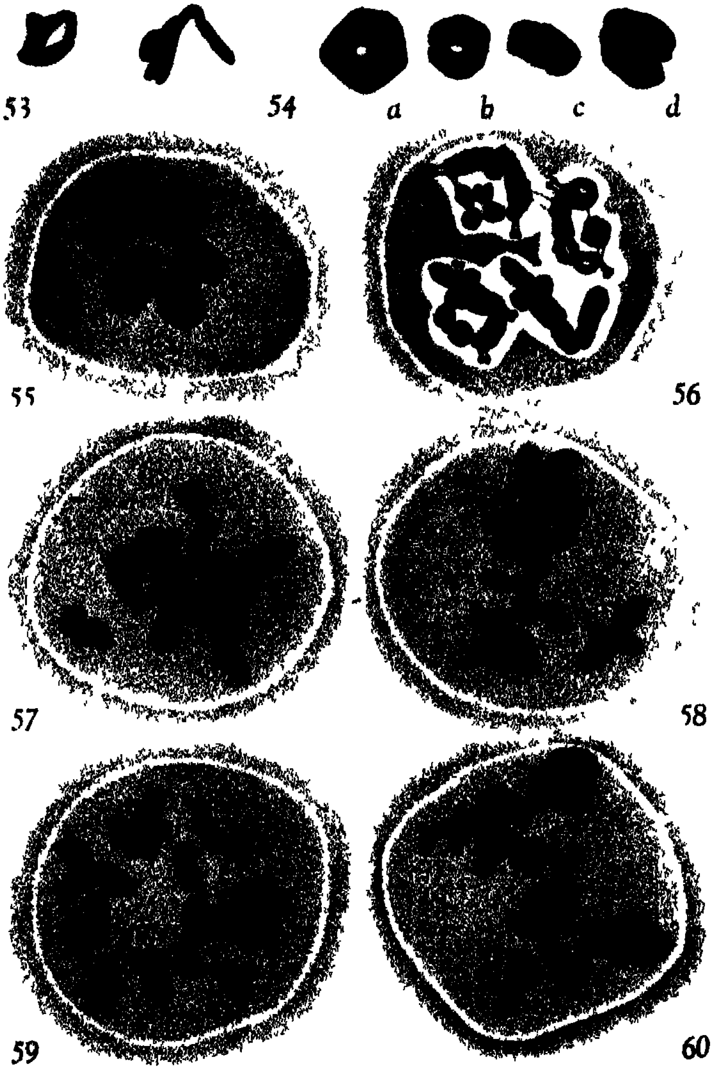


FIGS. 22–31 Prophase chromosomes of *Spironema fragrans* (Figs. 22–27, 29–31) and *Rhoeo discolor* (Fig 28). × 2000 except for Figures 30–31 (× 2800)

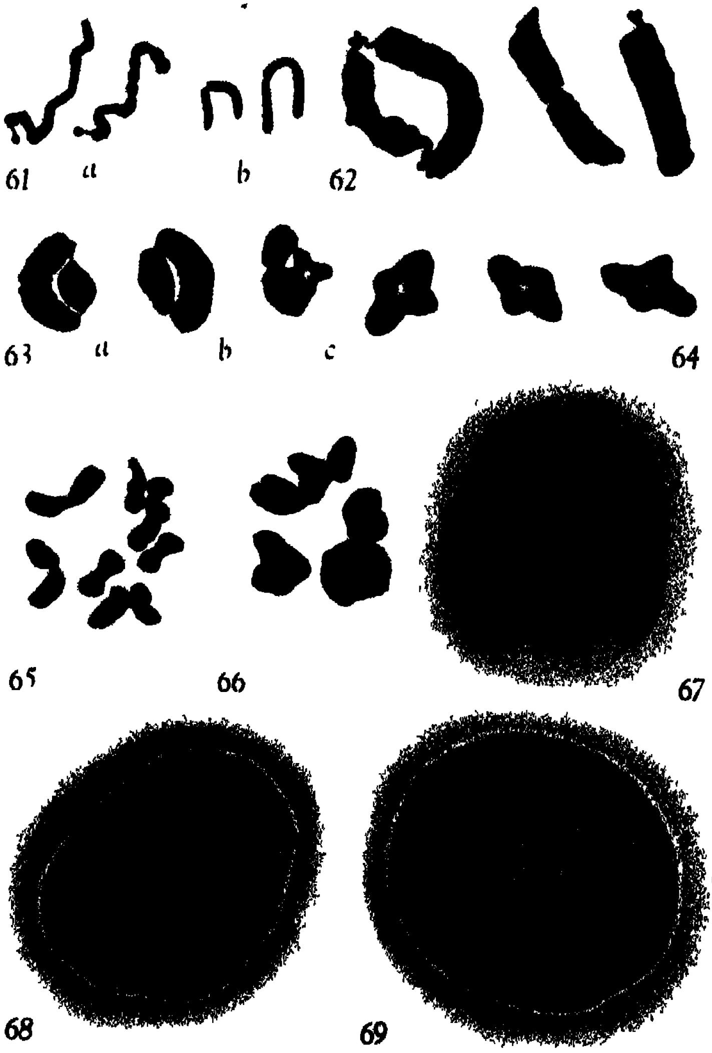


FIGS. 32–41. Chromosome development in *Spironema fragrans*. Figures 32, 34, 36, 40–41, × 2000; Figures 33, 37, × 2800, Figures 35, 38–39, × 2400

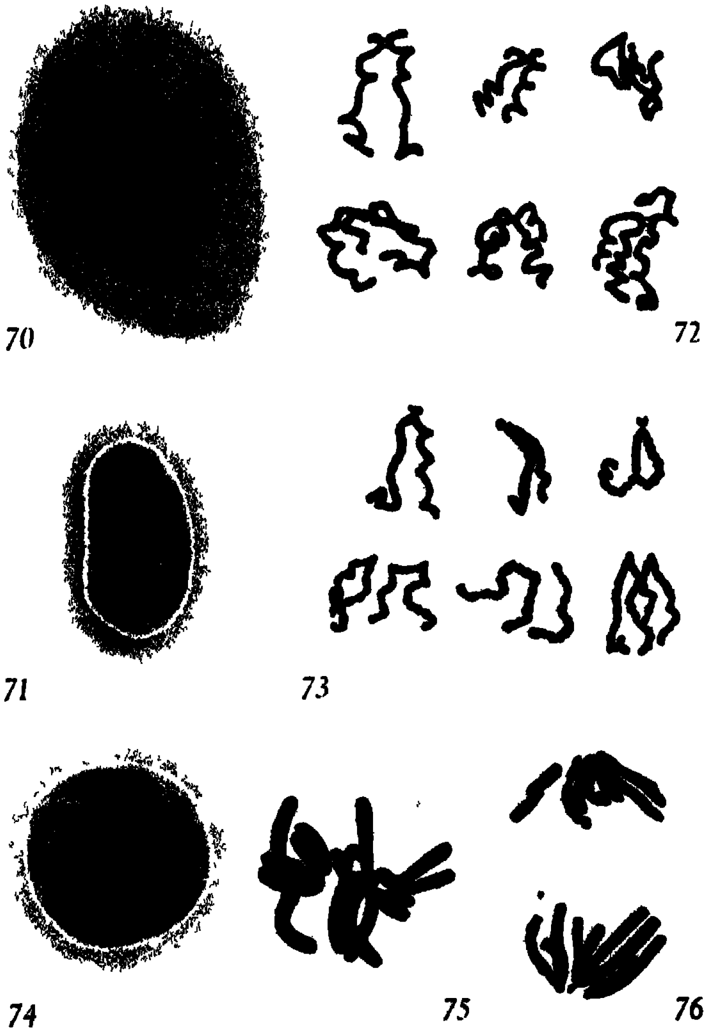
FIGS. 42–52 Nucleolus–chromosome relation in *Spironema fragrans* (Figs. 42–49) and *Rhoeo discolor* (Figs. 50–52). × 2000



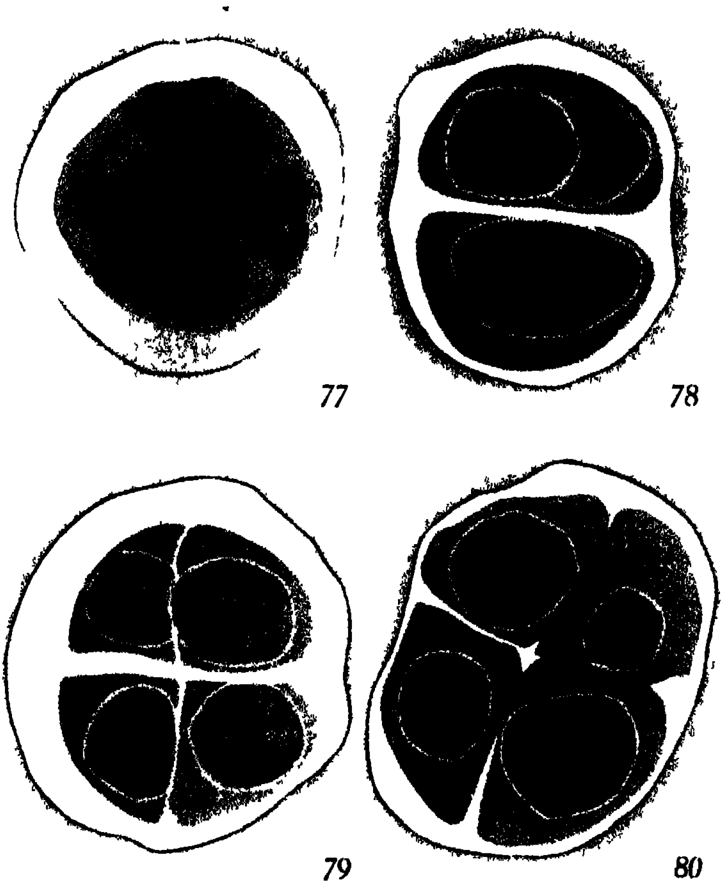
FIGS 53–60 Meiosis in *Rhoeo discolor* (Fig 53) and *Spironema fragrans* (Figs. 54–60) × 2000



FIGS. 61–69. Meiosis in *Spironema fragrans*. × 2000



FIGS 70–76 Meiosis in *Spironema fragrans*. × 2000



FIGS 77–80. Meiosis in *Spironema fragrans* × 2000

FORESTRY

SOME RESUPINATE POLYPORES FROM THE REGION OF THE GREAT LAKES XIII *

DOW V BAXTER

EMPHASIS on aviation in recent years has focused attention on types of wood appropriate for training planes and plane parts Among the softwoods the spruces are the most valuable for such construction Sitka spruce, *Picea sitchensis* (Bong) Carr , is of prime importance because of the amount of clear lumber that can be obtained from healthy individuals On the other hand, white spruce, *P glauca* (Moench) Voss, though it is a suitable material, is but little used in planes because it does not yield the necessary large quantities of clear lumber

The value of recognizing the fungi which cause defect in spruce wood is apparent, but, except for certain conspicuous species such as *Fomes pini* (Thore) Lloyd, *F laricis* (Jack) Murr , *Polyporus Schweinitzii* Fr , and *Pol sulphureus* (Bull) Fr studied by Boyce (5), it seems that the common fungi on both Sitka and white spruce have not been critically investigated

Recently, however, *Trametes serialis* in wood shipped from western North America has received attention abroad and also in the products' laboratories of this continent Even though the fungus is frequent on spruce timbers little is known of its extent and occurrence in the regions where much of our spruce grows The collections reported later in the present paper indicate that it has a wide distribu-

* Throughout the work on these monographs I am indebted to many institutions and individuals for help My appreciation is expressed to Professors T G Halle and Gunnar Samuelson, of Naturhistoriska Riksmuséet in Stockholm, with whom I have had the pleasure of association. Thanks are also due the staffs of the Division of Pathological and Mycological Collections and the Division of Forest Pathology of the United States Department of Agriculture I am under obligation, also, to Professor Walter H Snell, of Brown University Particular acknowledgment is made to the men who have accompanied me on my several expeditions to Alaska, the Yukon Territory, and the Northwest Territories Much credit is due them for aiding in the collection and care of specimens and for living, at times, under rather difficult circumstances

tion in both the coastal and the interior forests of Alaska, the Yukon Territory, and the Northwest Territories

These collections were gathered in the course of a comparative study of the resupinate polypores of the continent, and, consequently, no effort was made to investigate specifically the relative abundance of the spruce-inhabiting resupinates with reference to the incidence of such fungi as *Fomes pini* and *Polyporus Schweinitzii*, yet the records do make it clear that they are plentiful enough to be considered in any study of the rots of spruce woods Furthermore, since the data are based merely on random samples obtained on the several expeditions from 1932 to 1941 they suggest an even greater abundance of the fungi actually present in the areas

A number of the species which decay spruce wood are not, however, important agencies of rot in the standing trees, although *Trametes serialis*, one form at least, causes considerable defect in both standing and down redwood It is not known whether it occurs in other trees which attain large size, but its importance is recognized in structural timbers, particularly in Sitka spruce Whether *T serialis* developing in Douglas fir during transit is due to infection in the forest tree or in the wood after the tree is felled is a question which will undoubtedly receive attention in the future

Trametes serialis is often entirely resupinate in its growth habits Certain other closely allied polypores frequently resupinate on spruce wood are difficult to separate from *T serialis* and have been more than once identified as that plant This paper deals with *T serialis* and *T. alaskana* and, in connection with them, discusses the related forms *T heteromorpha* and *T variiformis*

Trametes serialis Fries, Hymen Eur., p 585 1874

(Plate I, Figure 1, Plates III–IV, IX)

Polyporus serialis Fries, Syst Myc, 1 370 1821
Polyporus callosus Fries, *ibid*, p 381
Polyporus scalaris Pers, Myc Eur, 2 90 1825
Poria callosa (Fr) Sacc, Syll Fung, 6 298 1888
Coriolellus serialis (Fr) Murr, N Am Fl, 9 29 1907
Poria Sequoiae Bonar, Journ For, 29 377 1931

Fructification coriaceous, effused-reflexed or resupinate, laterally confluent, frequently for as much as 2 5 feet, surface of pileus "appressed-tomentose, zonate 0–2 × 1–38 × 3–0 8 cm", margin thin, acute, undulating to lobed, concolorous, margin of

resupinate plants tomentose, up to 1 mm wide, sterile at first, becoming fertile with age, white to "ivory-yellow" to "honey-yellow", subiculum white, less than 1 mm, and mostly less than 0 5 mm, thick, tubes 1-8 mm long, often oblique, mouths white or "ivory-yellow," to "honey-yellow" to "buckthorn-brown" in old specimens, but usually white or white to yellowish and retaining this color in herbarium specimens, circular to angular, 2-4, mostly 2-3, to a mm, basidia hyaline, (5) 9-13 × 4-5 5 μ, spores smooth, hyaline, cylindric-ellipsoid, 7 9 × 2-3 μ,

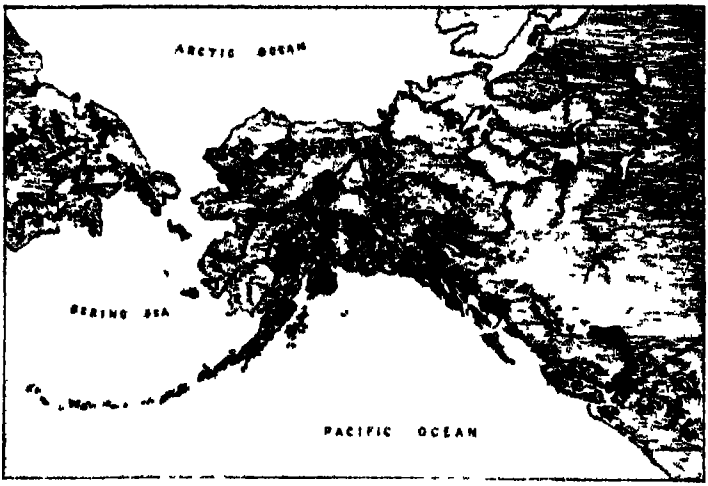


FIG 1 Distribution of *Trametes serialis* Fr north of Vancouver
● = one collection
⬤ = two or more collections

not guttulate, tramal hyphae smooth or incrusted, hyaline, apparently not branched, 3 5-4 μ in diameter, no clamp connections, no cystidia, chlamydospores appearing in cultures

Allied species — There are several resupinate polypores which are readily confused with *Trametes serialis* The difficulties of diagnosis are increased if the collections come from southeastern Alaska and coastal British Columbia, since in those regions there is a plant, *T alaskana*, sp nov (Pl II), which bears many resemblances to *T serialis.* This new species is much thicker and

has longer tubes and wider pore mouths than *T serialis* The greatest difficulty in separating the two plants will be experienced when *T alaskana* is young, since then the mouths may be similar in size in both species Even young specimens of *T alaskana*, however, are thick, and the mouths and tubes become large The two fungi may be distinguished readily in culture (see page 146)

If a pileus is present in *Trametes serialis* or *T heteromorpha* these two polypores can be readily separated The pileus of *T serialis* is brown, not white as is that of the other fungus Furthermore, the pore mouths of *T serialis* average 2–4, mostly 2–3, to a mm , whereas those of *T heteromorpha* are much larger, 0 5–3 to a mm

In the United States, and particularly in the Central West, South, and Southeast, *Trametes Morganii* Lloyd is often labeled *T serialis* For the most part, the specimens on poplar and oak called *T serialis* in herbaria throughout the country are actually *T Morganii* The comments of Lloyd (10) about the latter plant suggest relationships to *T rigida* also "Morgan referred it to *T rigida*, a southern plant " Less confusion should exist, however, between *T serialis* and *T rigida* than between *T Morganii* and *T rigida*

The fact that *Trametes Morganii* is not usually snow-white and that it occurs on hardwoods should be helpful in separating it from *T serialis* Furthermore, under most conditions *T serialis* does not form a pore surface over as wide an area as does *T Morganii*, though the lengthwise exteriors of both plants may be similar Such a feature is, however, only relative and can be used merely to supplement other features in distinguishing the two plants The spores of *T Morganii* are 12 × 6 μ according to Lloyd (10), but in my collections they correspond with those of *T serialis*, which are 7–9 × 2–3 μ

Trametes Morganii belongs to the "rapid-growth" [1] and "high-temperature" classes of fungi when placed in culture, whereas isolates of *T serialis* grow more slowly and fall into the "medium" group for temperature of optimum growth [2] Growth variations

[1] The terms used in this classification are defined in Papers V–VI (1–2) of the series

[2] The Humphrey and Siggers (9) classification is "Low-Temperature Group" (optimum 24° C and below), "Intermediate-Temperature Group"

in culture of different isolates from separated geographical regions point, however, to the fact that data obtained from cultures cannot be relied upon entirely to distinguish these fungi, particularly if the collection comes from northern North America. Cultures are valuable only to furnish information supplementary to that based on the morphological features.

Misdetermined specimens of ***Trametes malicola*** B. and C. are found in herbaria under the name *T. serialis*. The pileus, context, tubes, and pore mouths of *T. malicola* are light brown, not whitish as in *T. serialis*.

Resupinate specimens of ***Fomes fraxinophilus*** Pk. (which do occur in dry locations) may be macroscopically similar to *Trametes serialis*. But in addition to the fact that the former species is always on white or green ash or on buffalo berry, bracket-shaped or knoblike immature fruiting bodies of the species are usually found elsewhere on the tree. The fruiting bodies of *T. serialis* are never on the outside of the trunk of a standing tree, although they are often found on the walls inside the so-called "goose pens" in living redwood. The large spore of *T. serialis* can be used to separate the plants, since the spores of *F. fraxinophilus* are ovoid and measure 5–6 × 6–7 μ.

The species of Fomes which has been most commonly confused with *Trametes serialis*, however, is *F. annosus*. Because this latter plant is found often in the resupinate condition and because it is white, leathery in texture, and occurs on conifers, it is easy to account for such incorrect identification. The spores of *F. annosus* are ovoid, measuring 4–6 × 3–4 μ, and so are different in shape and size from those of *T. serialis*. They readily distinguish the two plants.

In regions of much rainfall, southeastern Alaska in particular, *Fomes pinicola* is often seen in the resupinate form. In the early stages of growth for the plants of this area it has been mistaken for *Trametes serialis*. The thick growth also suggests that of *T. alaskana*, but in species of Fomes the pores remain small. In *F. pinicola* the pore surface characteristically turns pale brown where bruised, *T. serialis* does not exhibit this feature. The

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(optimum 24° C. and 32° C.), and "High-Temperature Group" (optimum above 32° C.). Their isolate of *Trametes serialis* from Wisconsin falls in the "intermediate" group.

ovoid spores of *F pinicola* are likewise distinctive when contrasted with the cylindric-ellipsoid ones of *T serialis*

Poria unitus (*P medulla-panis*) also has been called *Trametes serialis* Its spores are 4-7 (4 × 5) 3-6 μ and so differ from the large spores of this species of Trametes The much-branched hyphae of *P unitus* are also a feature of that plant

In the Southwest *Polyporus anceps* Pk often occurs in a resupinate state, and specimens from that region have been misdetermined and deposited in herbaria under the name *Trametes serialis* Both plants appear on *Pinus ponderosa*, and it is usual for both to remain white after drying But the spores of *Pol anceps* measure 2-3 5 × 6-9 μ, whereas those of *T serialis* measure 7-9 × 2-3 μ

Old specimens of *Trametes serialis* may also suggest *Poria vaporaria*, particularly if the growth of the plant has been arrested somewhat during its development The width of the spores of *P vaporaria*, which are 5-6 × 1-2 μ, may be used to separate the two plants

Poria sitchensis Baxter also suggests, macroscopically, a small-pored growth form of *Trametes serialis* The spores of the latter plant, however, are much larger, 7-9 × 2-3 μ instead of 3 5-4 5 (4 × 1-1 5) 1-2 μ In culture the white to brown nodulose growth of the mycelium of *P sitchensis* is characteristic, whereas in all the many geographical isolates, including those from *Picea sitchensis*, the mycelium is white or whitish Exudations from the mycelium are also a feature of *Poria sitchensis* Furthermore, the two plants can be separated by the type of rot they produce in the host The wood beneath the fruiting body of *Poria sitchensis* is whitish, that under *T serialis* shows a brown, charcoal, or cubical rot

Specimens of *Trametes serialis* that are in part pink, red, or even "Hay's lilac" are occasionally observed I have collected many such discolored plants in the West and some in the Southwest and South, as well as in Sweden The majority are old when found These red but obviously once white fruiting bodies are to be seen in many herbaria The change in color has led collectors to attach a variety of names to such specimens of *Trametes serialis* Many are called, for example, *Poria sanguinolenta* Even Bresadola interpreted one of his specimens of *T serialis*

as *Polyporus incarnatus* This red or violet color may be caused by a discomycete which is seldom found in the fruiting stage or by the mycelia of an imperfect fungus

Habitat — *Abies arizonica, A balsamea, A concolor, A grandis, A magnifica, Arbutus Menziesii, Betula papyrifera, Juniperus* sp , *Larix europa, L laricina, L occidentalis, Picea Engelmannii, P glauca, P pungens, P rubra, P sitchensis, Pinus contorta, P flexilis, P monticola, P palustris, P ponderosa, P resinosa, P Strobus, P taeda, Pseudotsuga macrocarpa, P taxifolia, Sequoia sempervirens, Taxodium distichum, Thuja plicata, Tsuga canadensis, T heterophylla, T Mertensiana* Specimens are also reported on the hardwoods *Populus tremuloides, Quercus coccinea, Q Prinus, Q rubra,* and *Q velutina,* but in all probability many of these plants are *Trametes Morganii*

Distribution — Alberta, British Columbia, Manitoba, Newfoundland, Northwest Territories, Ontario, Yukon Territory, Alaska, Arizona, Arkansas, California, Colorado, Connecticut, Georgia, Idaho, Illinois, Iowa, Kansas, Kentucky, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, Tennessee, Texas, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming

Cultures — Isolated from a cotton mill in Rhode Island and furnished by Professor Walter H Snell This fungus belongs to the "rapid-growth" group of resupinate polypores as well as to the "large-range" and "high-temperature" classes

The optimum temperature for the germination of basidiospores in a culture from Madison, Wisconsin, was between 20° and 32° C , with the most rapid germination between 30° and 32° C , according to Snell (11) In his experiments the spores germinated at 30° but not at 40° C This temperature is lower than that required for germination by such fungi as *Lenzites saepiaria, L trabea, Lentinus lepideus,* and *Fomes roseus* Some of the spores of this *Trametes serialis* isolate germinated after four years and three months At 28° C. they ceased to germinate after an exposure of about ten weeks to dry incubator conditions, and at 36° C. most of the spores were killed within four weeks

The hyphae form a white cottony mat in cultures on blocks

and finally cover the wood with a snow-white mass of mycelium. This conifer-inhabiting plant produces even greater masses of mycelium in cultures containing hardwood (red-gum) blocks or in flasks containing both red-gum and white-pine wood than it does in those with white-pine blocks The fungus grows up and around the interior of a liter flask so as to fill much of the lower one third with mycelium (This luxuriant growth is an important feature, and may be used to separate *Trametes serialis* from *T alaskana*) The habit of growth becomes nodulose, particularly in flasks which contain hardwood blocks As the white mycelium ages it may darken in patches to "snuff-brown" or even to "Vandyke brown," and in some places it may form a brownish exudate Abortive irpiciform and poroid fruiting bodies may appear on the nodulose portions of cultures which are six months to one year in age, and they develop in flasks containing either coniferous or hardwood blocks

Decay — Comparatively few fungi which inhabit coniferous wood cause such significant amounts of decay in both structural timbers and standing trees as does *Trametes serialis* Both *Lenzites saepiaria* and *Poria incrassata*, for example, bring about enormous losses in coniferous structural wood, but they are of no economic concern in living trees, and though *P vaporaria* in Europe has been recorded as an important cause of rot in wood structures and also in green trees in the forest, the records of such incidence in standing conifers cannot be regarded as authentic The redwood form of *T serialis* is one polypore which attacks coniferous wood both in slash or structural timbers and in the living tree (Pls III–IV) In the Southwest *Polyporus anceps* Pk on ponderosa pine slash and in living trees is another well-known example of a fungus which destroys down material and causes heart rot in standing timber

Trametes serialis is best known in North America as the cause of a brown cubical rot of spruce and other coniferous logs and building timbers Cartwright (6) describes its penetration in Sitka spruce and concludes that the cellulose of the cell wall is altered or consumed in advance by the fungus, so that actual penetration by the hyphal tip, which is partly mechanical, is facilitated All except the finer hyphae are at first markedly constricted, but they soon resume normal size when the opposite

lumen is reached. Consequently, the bore hole is small at first and either may remain so or, after the cell wall is penetrated, may enlarge to many times the size of the hypha which formed it. The hypha in such a bore hole swells so that it no longer shows constriction. The mycelium in the wood has been revived after a dormant period of over seven and one-half years (8). This feature of resistance may possibly explain, in part, the frequent occurrence of *T. serialis* in buildings of certain types.

This fungus is an important agent of decay in storage yards in the Northwest. Lumber shipped abroad from mills in that region contained incipient decay of *Trametes serialis* which became apparent at the point of destination. Blair (3, 4) and Snell (11) report it, together with *Lenzites saepiaria*, *L. trabea*, and *Lentinus lepideus*, to be a source of decay in cotton-mill weave-shed roofs and basements in New England. It appears in flooring, in lumber yards, and in cabin timbers in Alaska. A "brown rot" of redwood exhibiting cubes that resemble those caused by *T. serialis* has been described, and a brown rot which breaks into cubes, apparently similar to that caused by *T. serialis* on coniferous blocks in culture, has been formed in cultures of the infecting fungus on wood. Spores of *T. serialis* from different localities show some variation in length, but, in general, are only one or two microns longer than those of *Poria Sequoiae*, described as causing a cubical rot of redwood. The spores of the latter fungus are given (7) as being 4.5–6 × 2–3.5 μ. The measurements recorded by various authorities for specimens of *T. serialis* are:

Murrill: 6–8 × 2.5–3 μ	Shope: 7–9 × 2–3 μ
Overholts: 7–8 × 2–3 μ	Bourdot and Galzin: 7–10 × 3–4 μ

Although the spores of *T. serialis* are usually 7–9 μ long, they occasionally exhibit considerable variation, i.e. from 6 to 10 μ, as indicated above. Those of a number of collections on different substrata in my herbarium show the following variations:

Host	*Spore measurements*
Lodgepole pine, Jasper, Alberta	5–6 × 2.5 μ
Sitka spruce, Skagway, Alaska	12 × 4 μ
Red spruce, Black Mountain, North Carolina	5–8 × 2–3 μ
Redwood, San Mateo, California	7–8 × 2 μ
Sitka spruce, Moose Pass (Grant Lake), Alaska	6.5–9 × 2–4 μ
White spruce, Great Slave Lake, Northwest Territories	5.5–7 × 2 μ

Trametes serialis is ordinarily more abundant on logs, on wood, and on structural materials in the coastal sections of Alaska than are such generally common plants as *Lenzites saepiaria* (Wulf) Fr and *T odorata* (Wulf) Fr in the States Environmental conditions in the southern areas of the Yukon Territory are dissimilar from those of the moist Pacific Coast of southeastern Alaska, and, consequently, *T serialis* (among the polypores), though common in lodgepole and other conifers of the section, does not appear so abundantly as does *T isabellina* Fr , a fungus frequently occurring on western and northern coniferous logs My most northerly record for *T serialis* in North America is from the Noatak River country north of the settlement of Kotzebue (north of Kotzebue Sound, Alaska)

In the Pacific Coast region of North America *Trametes serialis* results in a brown cubical rot in standing redwood The decay suggests that in incense cedar caused by *Polyporus amarus*, except that in the advanced stages the pockets become so numerous or individually so large that they may constitute almost a solid mass of rot (7) The wood surrounding the cubes is dull brown, in contrast to the clear bright red or red brown of sound timber Felts of white mycelium, which often become chalklike in age, frequently appear in the shrinkage cracks

There is some correlation between the incidence of rot and the presence of fire scars For decades and even for centuries ground fires have from time to time swept through the stands and exposed the aged heartwood in huge scars or goose pens Such injuries provide points of entrance for *Trametes serialis* and indirectly lead to much cull caused by the fungus The brown cubical rotted sections of the trunks are, in turn, more inflammable than is sound wood, and subsequent ground fires burn huge cavities in them Fruiting bodies of *T serialis* are often found on the walls of these goose pens

Most of the rot appears to be in the first twenty feet from the ground, but the decayed areas sometimes extend through the second thirty-six-foot log Decay also appears in the upper part of the trunk, but it has not been demonstrated as yet that it is caused by *Trametes serialis*

That *Trametes serialis* is not known to cause decay in standing

timber of other species even in the same forest is a fact difficult to explain Observations made on standing *Pseudotsuga taxifolia*, *Pinus monticola*, and *Abies grandis* growing in the redwood-forest areas have not revealed the presence of *T serialis*, although the fungus attacks wood from these trees But even old individuals of these species are much younger and smaller than redwood, so that there is less opportunity for the heartwood to become seasoned to the degree that it does in large specimens of Sequoia Furthermore, resin accumulates over many of the wounds caused by fire in such associates and this may prevent infection Redwood is not resinous and in old, immense specimens with large goose pens, it is probable that even the water-soluble extractives of the species which are toxic to fungi have leached out Such a condition of the wood in the exposed old heartwood of standing trees may correspond in a general way, then, to that of wood in logs Large specimens of *Thuja plicata*, *Libocedrus decurrens*, and *Chamaecyparis Lawsoniana* are also present in the northern areas of redwood, but these trees are neither so large nor so old as the Sequoia Furthermore, they do contain oils which are often toxic to polypores

Whatever the explanation may be for the incidence of the redwood form in standing trees, there is some relation between its occurrence and the presence of goose pens Such large cavities, which are largely nonexistent in most other trees, may create internal atmospheric conditions more favorable for the growth of *T serialis*

Because goose pens result from repeated fires an effort should be made to prevent burning over redwood lands It is believed that much cull can be eliminated in future stands by improving present methods of logging The various types of high-lead steam skidding now in use cause excessive damage The "slack-line" system employed by at least some companies leaves virtually no standing green timber on the land. Residual stands on adjacent areas logged over by tractor-arch units indicate that some progress can be made toward minimizing mechanical injuries and devastation The undesirability of the custom of resorting to fire to rid a logged-over area of the débris incidental to the felling, limbing, and bucking operations is evident (7)

Trametes alaskana, sp. nov.

(Plate I, Figure 2, Plates II, V–VII)

Type and important specimens

Trametes alaskana on *Picea sitchensis*, Cordova, Alaska, type Coll Dow V Baxter, Aug 21, 1933 Herb Dow V Baxter, Ann Arbor

Trametes alaskana on *Picea sitchensis*, Sitka, Alaska Coll Dow V Baxter, Sept 1, 1933 Herb Dow V Baxter, Ann Arbor

Trametes alaskana on structural timber beneath bank building, Valdez, Alaska Coll Dow V Baxter, July 13, 1933 Herb Dow V Baxter, Ann Arbor

Trametes alaskana on *Picea sitchensis*, Seward, Alaska Coll Dow V Baxter, Aug 14, 1933 Herb Dow V Baxter, Ann Arbor

Fructificatio annua vel perennis, plus minusve 1 m effusa, coriacea, usque 1 5 cm crassa, resupinata vel semiresupinata, saepe nodulosa, margo primum sterilis, 1 5 cm latus, plerumque minus quam 2 mm latus, albidus vel pallide albidus, sed in crassis speciminibus, si margo non fit fertilis, brunneus, subiculum albidum, tubi plerumque 5-6 mm longi, sed nonnumquam 22 mm longi, saepe irpiciformes vel lamellati, albidi vel pallide ochracei, aperturae cum tubis concolores, 1–3, plerumque 1–2, in uno mm, sporae hyalinae 10–12 × 3 μ, hyphae 2–4 μ diam, raro ramosae vel septatae

Fructification annual or perennial, effused for 1 meter or less, coriaceous, up to 1 5 cm wide, mostly less than 2 mm wide, at first whitish, changing to "avellaneous" or, in thick specimens where the margin does not become fertile, "natal brown", subiculum whitish, tubes mostly 5–6 mm, but up to 22 mm, long, frequently becoming irpiciform or lamellate, whitish to avellaneous, mouths concolorous with the tubes, 1–3, mostly 1–2, to a mm, spores hyaline, 10–12 × 3 μ; hyphae 2–4 μ, seldom branched and seldom septate

Allied species — *Trametes alaskana* is allied to *T serialis*, *T heteromorpha* Fr, and *T variiformis* Pk These plants, in fact, are so closely related in some of their growth forms (particularly when in the resupinate state) that only with an abundant amount of material available in the field can some of them be distinguished accurately without the use of cultures If it is possible to do so, one should obtain old as well as young material for representative samples

For a number of years young plants of *Trametes alaskana* coming from coastal Alaska and having small tube mouths were ten-

tatively named *T serialis* (Pl V) Such young plants, however, are always thick and later have wide mouths

Likewise, white or whitish specimens with wide mouths and a nodulose form of growth were tentatively referred to *Trametes heteromorpha* Furthermore, specimens of *T variiformis* which lacked pilei and which grew in similar habitats were confused with both *T alaskana* and *T heteromorpha* Consequently, authentic material of Swedish plants has been studied in Sweden

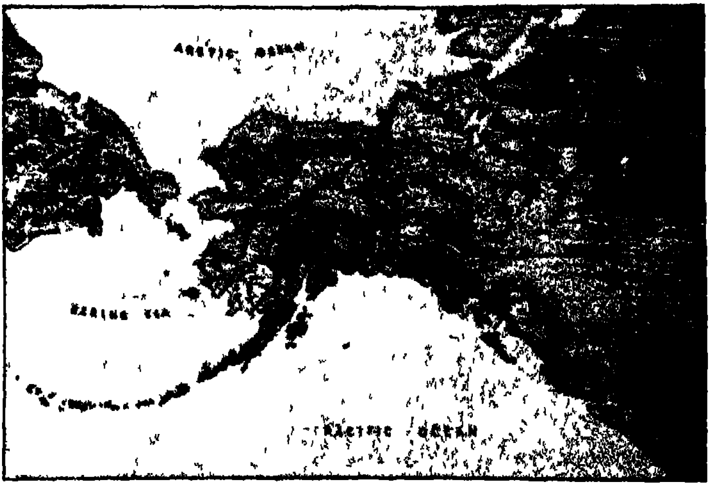

Fig 2 Distribution of *Trametes alaskana* north of Vancouver
● = one collection
⬤ = two or more collections

as well as on this continent and numerous collections have been made Cultures were obtained from certain specimens from widely separated localities, and the data from the cultures were matched with the morphological features of the fruiting bodies

The thick habit of growth even in young specimens of *Trametes alaskana* should help to separate it from *T serialis* In addition, *T serialis* often remains whitish in herbarium specimens, whereas the Alaskan plant discolors upon drying

Mature specimens of *Trametes alaskana* and *T variiformis* are similar in the size of the pores. *T alaskana*, however, forms a

thick growth over the substratum, whereas *T variiformis* forms a relatively thin one The tubes of *T variiformis*, although definitely coriaceous, are more paper-like and certainly less coarse (Pls VIII–IX) Pilei are unknown in *T alaskana*, in *T variiformis* the pileus, if present, has a brown surface An indication of this brown color can be detected at the margins even of many resupinate plants Marginal growth is exceedingly irregular and wavy in *T variiformis*, so much so that the plant frequently

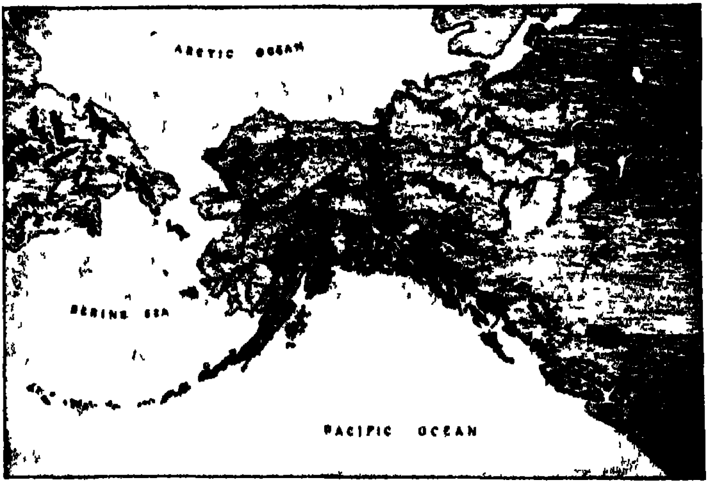

FIG 3 Distribution of *Trametes variiformis* north of Vancouver
● = one collection
⬤ = two or more collections

occurs in small patches, often more or less circular, on a decorticated log, or in the checks of charred timber, rather than in long, rather wide, continuous sheets This habit of growth, though noticeable in *T heteromorpha*, *T alaskana*, and *T serialis*, is not so conspicuous in those species Both *T heteromorpha* and *T. alaskana* frequently exhibit a nodulose habit of growth

The pileus of *Trametes heteromorpha* is white, and in resupinate specimens marginal portions may suggest the white of a pileus Resupinate plants of *T heteromorpha* appear in two different growth forms, one having long coriaceous tubes with thick dis-

sepiments (as in *T alaskana*) and usually remaining white or whitish (Pl X), and one having short somewhat irpiciform (or sinuous, as in *Poria sinuosa*) tubes and becoming "ochraceous buff," or at least not remaining whitish (Pl XI) These forms may be distinguished from *T alaskana* with long white tubes by the fact that the latter, instead of remaining white, exhibits brown discolorations in the upper marginal parts, and from *T alaskana* with relatively short tubes, by the fact that *T heteromorpha* remains white or whitish and has characteristically thinner dissepiments Emphasis is to be placed always on the thick growth features of *T alaskana*

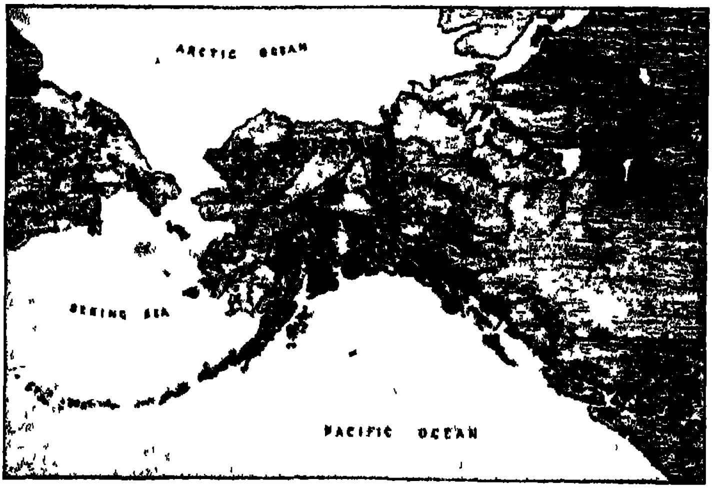

FIG 4 Distribution of *Trametes heteromorpha* Fr north of Vancouver
● = one collection
⬤ = two or more collections

Habitat — *Picea glauca, P sitchensis, Tsuga heterophylla* This species will probably be found in Douglas fir in British Columbia, Oregon, and Washington

Distribution — Yukon Territory, Alaska This plant probably occurs also in British Columbia, northern California, Oregon, and Washington

Occurrence — *Trametes alaskana* is, in general, restricted to the

TABLE I

COLLECTIONS OF *TRAMETES SERIALIS* ON VARIOUS SUBSTRATA FROM NORTHERN NORTH AMERICA

(Herb Dow V Baxter)

Substratum	Form of timber	Locality	Expedition
Tsuga heterophylla	Decorticated log	Sitka, Alaska	1933
Picea glauca	Decorticated log	Fort Wrigley, Northwest Territories, Canada	1937
	Decorticated log	Ruby, Alaska	1936
Picea glauca	Decorticated log	Nenana, Alaska	1936
Picea glauca	Decorticated log	Moose Pass, Alaska	1938
Picea glauca	Log with bark	Burnt Island, Great Slave Lake, Northwest Territories, Canada	1937
Pseudotsuga taxifolia		Vancouver, British Columbia, Canada	1933
Picea sitchensis ?	Caps and posts used in tunnel supports	Tunnel, Alaska	1939
Picea glauca	Stack support in lumber yard	Fairbanks, Alaska	1936
Picea glauca	Decorticated log	Lower Russian Lake, Kenai Peninsula, Alaska	1936
Picea glauca	Decorticated log	Burnt Island, Great Slave Lake, Northwest Territories, Canada	1937
Pseudotsuga taxifolia	Decorticated log	Jasper, Alberta, Canada	1935
Picea glauca	Old lumber	Fairbanks, Alaska	1933
Picea glauca	Decorticated log	Waterways, Alberta, Canada	1937
Picea glauca	Decorticated log	Fort Smith, Northwest Territories, Canada	1937
Pinus contorta	Charred log	Jasper, Alberta, Canada	1935
Picea sitchensis	Decorticated log	Skagway, Alaska	1932
Picea glauca	Decorticated log	Dawson, Yukon Territory, Canada	1935
Tsuga heterophylla		Vancouver, British Columbia, Canada	1933
Pseudotsuga taxifolia	Decorticated log	Hope, British Columbia, Canada	1937

TABLE I (*Concluded*)

Substratum	Form of timber	Locality	Expedition
Picea glauca	Decorticated log	Tanana, Alaska	1936
Picea glauca	Log with bark	Burnt Island, Great Slave Lake, Northwest Territories, Canada	1937
Picea glauca	Old tramway timbers on 1898 trail	Whitehorse, Yukon Territory, Canada	1935
Picea sp	Base log in house	Fairbanks, Alaska	1940
	Decorticated log	Lake Louise, Alberta, Canada	1933
Picea glauca	Decorticated log (overgrowing specimen of *T variiformis*)	Fairbanks, Alaska	1933
Picea glauca	Decorticated log	Beaver, Alaska	1935
Tsuga Mertensiana	Discarded railroad ties	Fairbanks, Alaska	1933
Picea sitchensis	Decorticated log	Seward, Alaska	1933
Picea glauca	Decorticated log	Carcross, Yukon Territory, Canada	1932
Picea glauca		Hot Springs, Alaska	1936
Picea sitchensis	Decorticated log	Seward, Alaska	1933
	Decorticated log	Grant Lake, Kenai Peninsula, Alaska	1938
Picea glauca	Decorticated log	50 miles south of Kotzebue, Alaska	1940
Picea glauca	Log with bark	Noatak River, 40 miles north of Kotzebue, Alaska	1940
Picea glauca	Decorticated log	Unalakleet, Alaska	1941

northwest coastal regions of the continent Only two collections have been made elsewhere, one at Carcross, Yukon Territory, and one at Koyukuk, Alaska The plant is found on structural timbers and decorticated logs

Though a study was not made in the field to determine the abundance of the species and though collections were not taken of every specimen observed in the forests, the results of the random sample from the region north of Vancouver, British Columbia, of 146 collections in which *Trametes serialis*, *T alaskana*, *T variiformis*, and *T heteromorpha* are present are of interest (see Figs 1–4, pp 141, 151–153, and Tables I–IV, pp 154–156, 158–160) Sixty per cent of the collections of *T alaskana* occur on Sitka

TABLE II

COLLECTIONS OF *TRAMETES ALASKANA* ON VARIOUS SUBSTRATA FROM NORTHERN NORTH AMERICA

(Herb Dow V Baxter)

Substratum	Form of timber	Locality	Expedition
Picea sitchensis	Decorticated log	Cordova, Alaska	1933
Tsuga heterophylla	Decorticated log	Ketchikan, Alaska	1933
Picea sitchensis	Decorticated log	Ptarmigan Lake, Kenai Peninsula, Alaska	1933
Tsuga heterophylla	Decorticated log	Wrangell, Alaska	1935
Tsuga heterophylla	Decorticated log	Cordova, Alaska	1933
Tsuga heterophylla	Decorticated log	Sitka, Alaska	1933
Tsuga heterophylla	Decorticated log	Sitka, Alaska	1933
Picea sitchensis	Decorticated log	Cordova, Alaska	1933
Picea sitchensis	Decorticated log	Seward, Alaska	1933
Picea sitchensis	Decorticated log	Cordova, Alaska	1933
Picea sitchensis	Decorticated log	Ketchikan, Alaska	1933
Picea sitchensis	Decorticated log	Mills Bay, Kodiak, Kodiak Island, Alaska *	1938
Picea sitchensis	Decorticated log	Skilak Glacier, Kenai Peninsula, Alaska	1938
Picea sitchensis	Reconstructed Russian blockhouse timbers	Sitka, Alaska	1939
Picea glauca	Decorticated log	Koyukuk, Alaska	1936
Picea glauca	Decorticated log	Carcross, Yukon Territory, Canada	1932
Picea sitchensis	Structural timber	Cordova, Alaska	1933
Picea sitchensis	Decorticated log	Hope, Alaska	1933
Tsuga heterophylla	Decorticated log	Wrangell, Alaska	1935
Picea sitchensis	Decorticated stump	Ketchikan, Alaska	1933
	Structural timber beneath bank	Valdez, Alaska	1933
Picea sitchensis	Decorticated log	Sitka, Alaska	1933
Picea sitchensis	Decorticated log	Sitka, Alaska	1933
Picea sitchensis	Decorticated log	Cordova, Alaska	1933
Picea glauca	Decorticated log	Lower Russian Lake, Kenai Peninsula, Alaska	1936
Tsuga Mertensiana	Decorticated log	Mole Harbor, Admiralty Island, Alaska	1941
Picea sitchensis	Decorticated log	Lost Lake trail, vicinity of Seward, Alaska	1941

* The most westerly collection in the North American coastal forest

spruce, in contrast to eleven per cent of those of *T serialis* Eighteen per cent of all these species in the 146 collections are *T alaskana* At least sixty per cent of the entire group of plants occur on either *Picea sitchensis* or *P glauca*, and seventy-one per cent of the specimens of *T alaskana* are on spruce *T alaskana* and *T heteromorpha* are more abundant on *P sitchensis* than is either *T variiformis* or *T serialis* *T heteromorpha* is more likely to appear on wood with bark than *T alaskana* or any other of these fungi

Cultures — Isolated from *Trametes alaskana* on *Picea sitchensis*, Kodiak Island, Alaska, the specimen was collected at the extreme limits of the coastal coniferous forest of the continent Another Alaskan isolate of this same variety came from Sitka-spruce stringers in a mill yard, Juneau, Alaska

It is usual for isolates made from various sources to differ, but these Alaskan plants are members of a growth group dissimilar from that into which *Trametes serialis* falls Both isolates belong to the "slow-growth" group and the "small-range" and "average-temperature" classes

Trametes alaskana grows much more slowly than *T serialis* The types of growth exhibited by the two fungi in culture also differ *T alaskana* (isolate from Juneau) does not form a thick enveloping growth over the wood in either white-pine or red-gum block cultures, but the mycelium of *T serialis* in both hardwood and coniferous cultures almost completely hides the wood This point is of interest, since in nature *T alaskana* is the thick form Nor does this fungus exhibit the conspicuous nodulose growth habit of *T serialis* Though both species formed tubes and pores in ten-month-old cultures on red-gum blocks, only *T serialis* fruited in similarly aged cultures on pine blocks Much longer tubes were produced in cultures of *T alaskana* than in ones of *T serialis*

Cultures of *Trametes variiformis* (isolate from Toklat River, Mt McKinley National Park, Alaska) are helpful in distinguishing it from both *T alaskana* and *T serialis* Red-gum blocks are not hidden from view by *T variiformis* even in two-year-old cultures This feature suggests *T alaskana* in culture In contrast to the latter species, however, a nodulose growth (less luxuriant than that of *T serialis*) is produced Pore formation

TABLE III

COLLECTIONS OF *TRAMETES VARIIFORMIS* ON VARIOUS SUBTRATA FROM NORTHERN NORTH AMERICA

(Herb Dow V Baxter)

Substratum	Form of timber	Locality	Expedition
Picea glauca	Decorticated log	Mile 6, Mt McKinley National Park, Alaska	1933
Picea glauca	Decorticated log	Toklat, Mt McKinley National Park, Alaska	1933
Tsuga sp	Decorticated log	Ptarmigan Lake, Kenai Peninsula, Alaska	1933
Picea sp	Decorticated log	Tanana, Alaska	1936
Picea glauca	Decorticated log	Lower Russian Lake, Kenai Peninsula, Alaska	1936
Picea glauca	Decorticated log	Carcross, Yukon Territory, Canada	1932
Picea glauca	Decorticated log	Mt McKinley National Park, Alaska	1932
	Decorticated log	Carcross, Yukon Territory, Canada	1932
Pinus contorta	Decorticated log	Lake Louise, Alberta, Canada	1933
Picea glauca		Koyukuk, Alaska	1936
Picea sitchensis	Decorticated log	Moose Pass, Alaska	1933
Pinus contorta	Decorticated log	Jasper, Alberta, Canada	1935
Picea glauca	Decorticated log	Sheep Creek, Alaska	1935
Picea glauca	Decorticated log	Sitka, Alaska	1933
Picea sitchensis	Decorticated log	Seward, Alaska	1935
Picea glauca	Decorticated log	Koyukuk, Alaska	1936
Pinus contorta	Decorticated log	Jasper, Alberta, Canada	1935
Picea glauca	Decorticated log	Carcross, Yukon Territory, Canada	1932
Picea glauca	Decorticated log	Fort Smith, Northwest Territories, Canada	1937
Picea sitchensis	Decorticated log	Moose Pass, Alaska	1938
Picea glauca	Decorticated log	Koyukuk, Alaska	1936
Picea glauca	Decorticated log	Fort Wrigley, Northwest Territories, Canada	1937
Picea glauca	Decorticated log	Koyukuk, Alaska	1936
Picea glauca	Decorticated log	Burnt Island, Great Slave Lake, Northwest Territories, Canada	1937
Picea sitchensis	Decorticated log	Seward, Alaska	1933
	Decorticated log	Lower Tanana River (east of Tanana), Alaska	1936

TABLE III (*Concluded*)

Substratum	Form of timber	Locality	Expedition
	Charred log	Carcross, Yukon Territory, Canada	1932
	Charred log	Skagway, Alaska	1932
Picea glauca	Decorticated log	Sheep Creek, Alaska	1935
Picea sp	Decorticated log	Stillwater Crossing, Alaska	1936
	Decorticated log	Dawson, Yukon Territory, Canada	1935
Picea glauca	Decorticated log	Selkirk, Yukon Territory, Canada	1935
	Decorticated log	Ptarmigan Lake, Kenai Peninsula, Alaska	1933
Picea sitchensis	Charred log	Hope, Alaska	1933
Pinus contorta	Charred log	Skagway, Alaska	1932
Pinus contorta	Charred log	Jasper, Alberta, Canada	1935
Pinus contorta ?	Decorticated log	Lake Louise, Alberta, Canada	1933
	Charred log	Carcross, Yukon Territory, Canada	1932
Tsuga heterophylla	Decorticated log	Wrangell, Alaska	1935
Picea sitchensis	Decorticated log	Moose Pass, Alaska	1936
Picea glauca	Decorticated log	Selkirk, Yukon Territory, Canada	1935
Picea glauca	Charred log	Carcross, Yukon Territory, Canada	1932
	Decorticated log	Selwyn, Yukon Territory, Canada	1935
Picea glauca	Decorticated log	Mt McKinley National Park, Alaska	1933
Picea glauca	Decorticated log	Lower Russian Lake, Kenai Peninsula, Alaska	1936
Pinus contorta	Decorticated log	Carcross, Yukon Territory, Canada	1932
Picea glauca	Decorticated log (overgrowing specimen of *serialis*)	Fairbanks, Alaska	1933
Picea glauca	Decorticated log	Selkirk, Yukon Territory, Canada	1935
Pinus contorta	Charred log	Skagway, Alaska	1932
Picea glauca	Decorticated log	Noatak River (Kotzebue Sound vicinity), Alaska	1940

TABLE IV

COLLECTIONS OF *TRAMETES HETEROMORPHA* ON VARIOUS SUBSTRATA FROM NORTHERN NORTH AMERICA

(Herb Dow V Baxter)

Substratum	Form of timber	Locality	Expedition
Picea sitchensis	Decorticated log	Juneau, Alaska	1936
Tsuga Mertensiana	Decorticated log	Cordova, Alaska	1933
Tsuga heterophylla	Log with bark	Wrangell, Alaska	1935
Picea sitchensis	Decorticated log	Seward, Alaska	1933
Tsuga Mertensiana	Decorticated log	Cordova, Alaska	1933
Picea sitchensis	Log with bark	Hope, Alaska	1933
Picea sitchensis		Sitka, Alaska	1933
Picea glauca	Decorticated log	Toklat, Mt McKinley National Park, Alaska	1933
Tsuga heterophylla	Log with bark	Sitka, Alaska	1933
Tsuga Mertensiana	Log with bark	Hope, Alaska	1938
Picea sitchensis	Log with bark	Juneau, Alaska	1936
Picea glauca	Decorticated log	Birch Lake, Alaska	1940
Salix sp	Limb with bark	Birch Lake, Alaska	1940
Tsuga sp	Log with bark	Skagway, Alaska	1932
Picea sitchensis	Log with bark	Juneau, Alaska	1936
Tsuga heterophylla	Decorticated log	Ketchikan, Alaska	1933
Tsuga Mertensiana	Log with bark	Hope, Alaska	1933
Picea sitchensis	Log with bark	Lawing, Alaska	1936
Picea glauca	Log with bark	Nenana, Alaska	1936
Picea glauca	Decorticated log	Sitka, Alaska	1933
Picea sitchensis	Log with bark	Uzinki (Kodiak Island group), Alaska	1938
Picea glauca	Log with bark	Fort Wrigley, Northwest Territories, Canada	1937
Tsuga Mertensiana	Log with bark	Ptarmigan Lake, Alaska	1933
Picea sitchensis	Limb with bark	Lower Russian Lake, Kenai Peninsula, Alaska	1936
Populus balsamifera (growing with *Picea glauca*)	Decorticated limb	Fort Wrigley, Northwest Territories, Canada	1937
Picea glauca (growing with *Populus balsamifera*)	Log with bark	Fort Wrigley, Northwest Territories, Canada	1937
Tsuga sp	Log with bark	Seward, Alaska	1933
	Log with bark	Lower Russian Lake, Kenai Peninsula, Alaska	1936
	Snag with bark	Lawing, Alaska	1940
	Log with bark	Lower Russian Lake, Kenai Peninsula, Alaska	1936
Picea glauca	Log with bark	Lower Russian Lake, Kenai Peninsula, Alaska	1936
Tsuga Mertensiana	Log with bark	Hope, Alaska	1933
Picea glauca	Snag with bark	Lake Illiamna, Alaska	1941

resembling that of *T heteromorpha* in nature appears in the cultures

It is evident from these records that comparative studies of the species of Trametes in culture and of those of closely related genera are necessary The variation that exists among isolates obtained from different regions makes such studies all the more imperative

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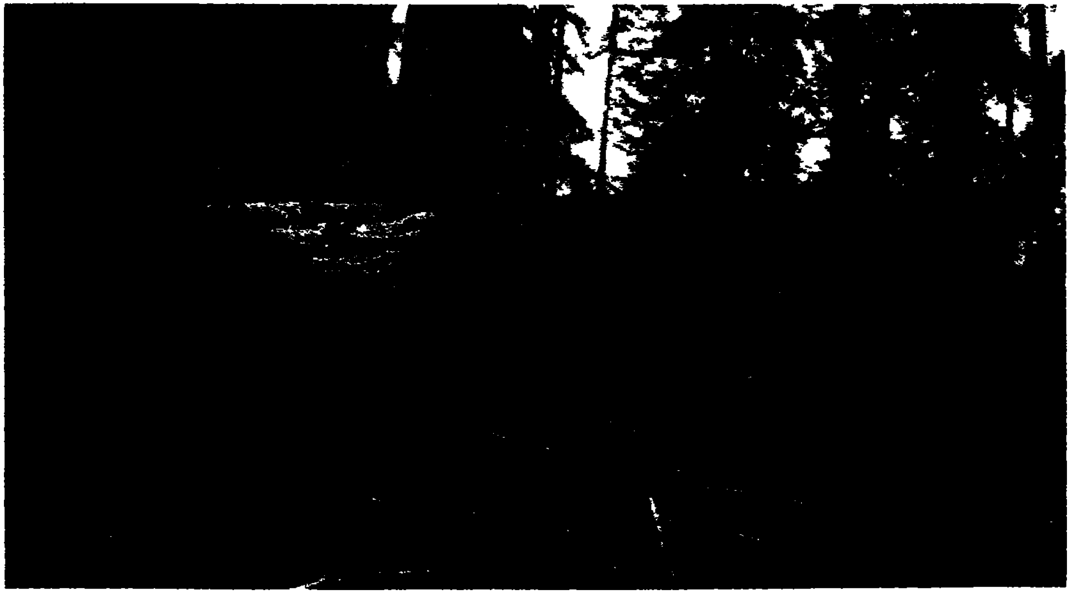
PLATES I–XI

FIG. 1 *Trametes serialis* Fr. Moose Pass, Alaska, 1938

FIG. 2 *Trametes alaskana*, sp. nov., on *Picea sitchensis*, Seward, Alaska, 1933

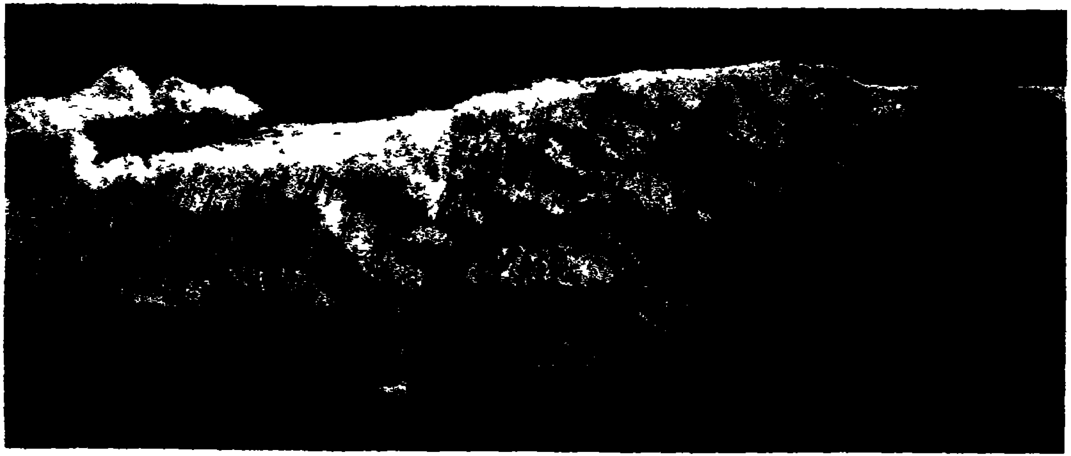
Trametes alaskana, sp. nov., on *Picea sitchensis* Sitka, Alaska, 1933

Trametes serialis Fr (or a form of this species) on *Sequoia sempervirens*, Scotia, California

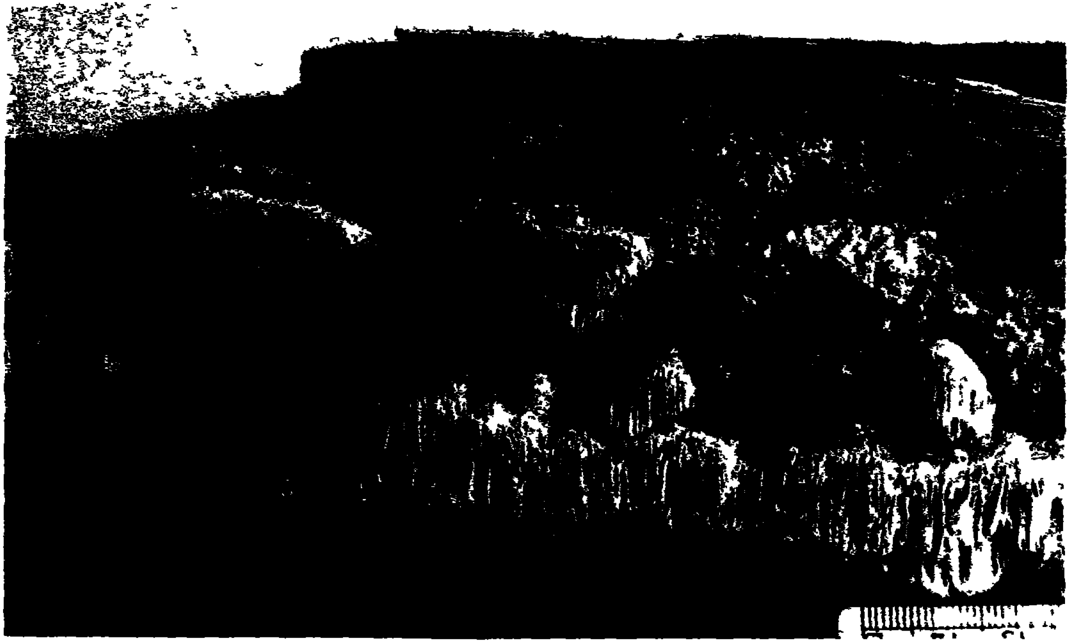


Rot caused by *Trametes serialis* Fr. (or a form of this species) in goose pen of redwood, Scotia, California

Trametes alaskana, sp nov (labeled *T serialis* in field see pp 150–151), Mills Bay Kodiak Island, Kodiak, Alaska This collection was made at the limits of the coastal coniferous forest in North America The fungus grew through the field label during transit to Ann Arbor Thick growth habit and large pores are characteristic even of young plants



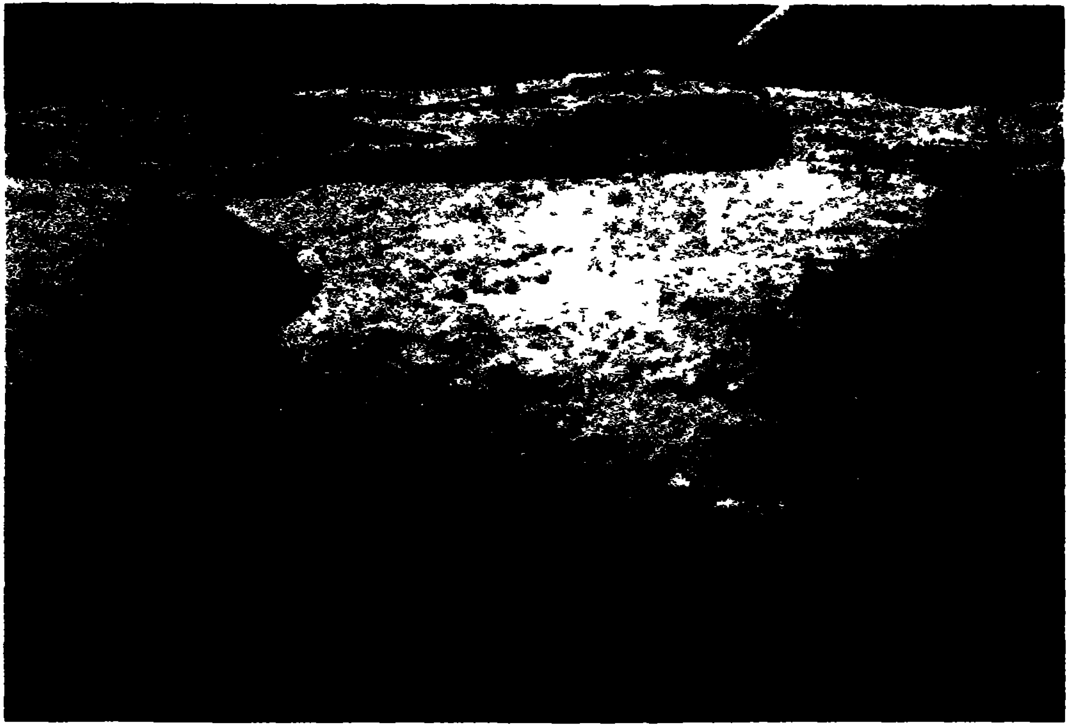
Trametes alaskana, sp. nov., on *Picea glauca*, Carcross, Yukon Territory. This is one of the few collections of this species from the interior forest regions of the continent (Carcross is just over the mountains from the coastal forest).



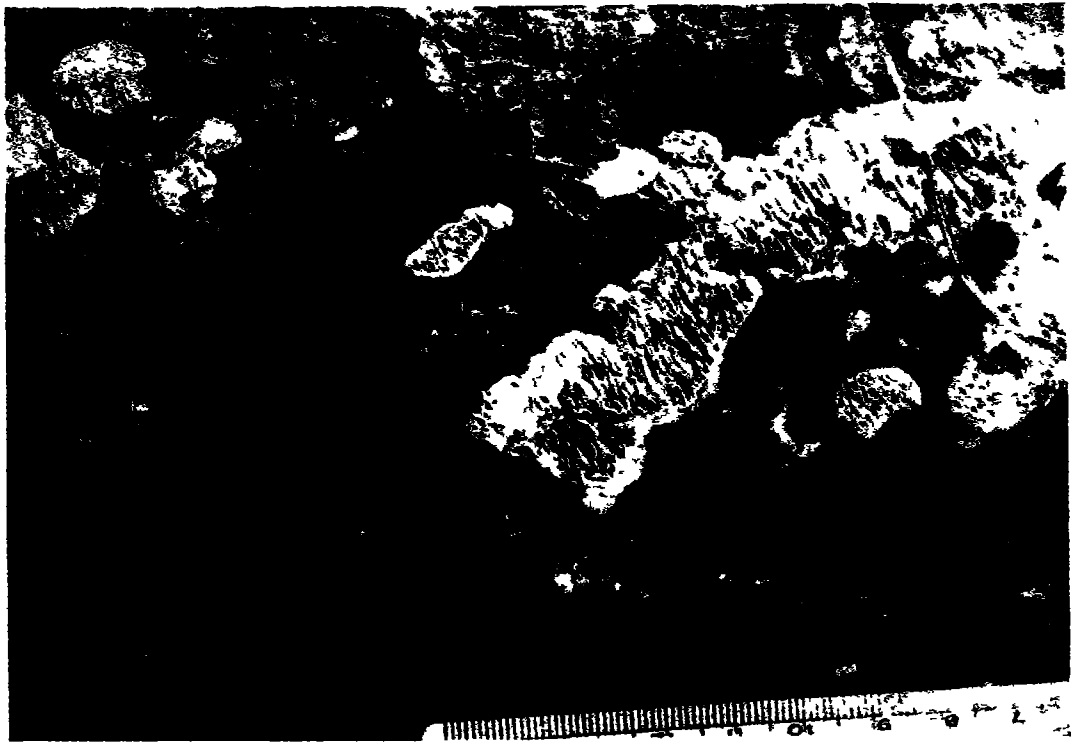
Trametes alaskana, sp nov, on structural timber beneath bank building, Valdez, Alaska, 1933

FIG 1 *Trametes variiformis* Pk on *Picea sitchensis*, Moose Pass, Alaska, 1933

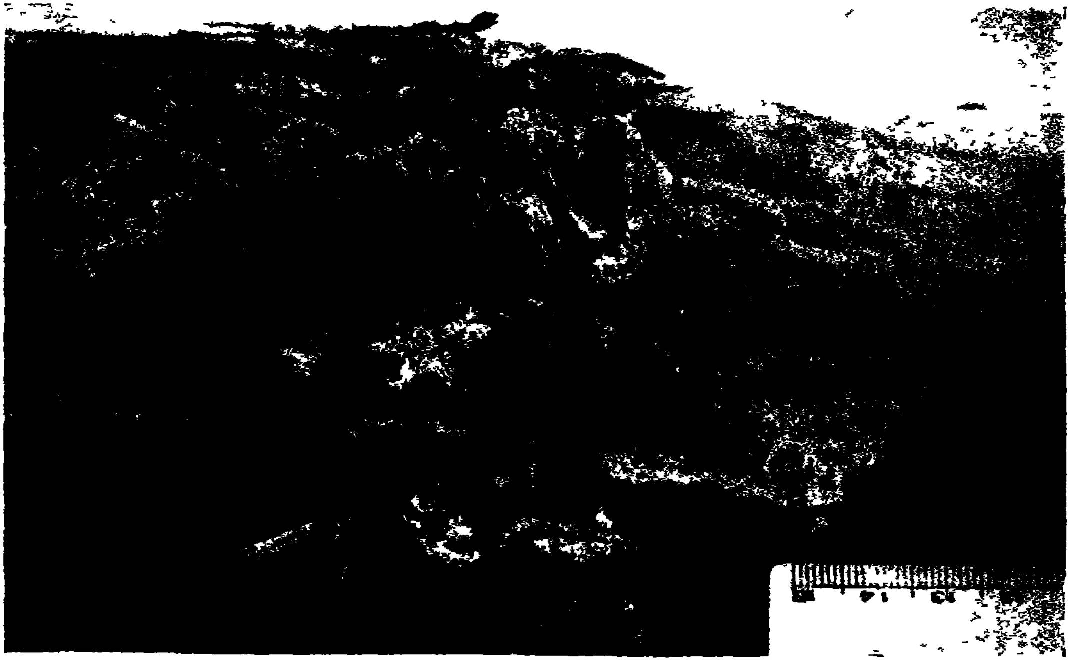
FIG 2 Resupinate *Trametes variiformis* Pk Ptarmigan Lake, Kenai Peninsula 1933 This fungus is more abundant on slash in this region than is *Lenzites saepiaria* (Wulf) Fr



Trametes variiformis Pk (top of log) and *T. serialis* Fr on *Picea glauca*, Fairbanks, Alaska, 1933



Resupinate *Trametes heteromorpha* Fr., Lower Russian Lake, Alaska



Resupinate *Trametes heteromorpha* Fr on *Picea glauca*, Lower Russian Lake, Alaska. In this stage of growth the fungus suggests *Poria sinuosa*

SAPWOOD IN SUGAR-MAPLE TREES

WILLARD S BROMLEY

THE amount of sapwood in sugar-maple (*Acer saccharum*) trees has a direct bearing upon the price paid for the lumber obtained from them The highest grades of sapwood lumber cut during winter, when the wood is whitest and is dried under special conditions, are sold for $20 more per thousand board feet than the best grades cut at other times Even when the trees are cut in the summer and given no special drying treatment boards of the better grades with sapwood on just one side are sold for $10 more per thousand board feet than lumber of the same grade cut from the heartwood of trees Although the presence or the absence of sapwood affects the price of sugar-maple lumber very materially, there is but little information in American literature concerning the width of the sapwood in the trees from which the lumber is sawed It is the purpose of this paper to present the results of many measurements of maple trees and to discuss some of the factors which seem to affect the width of their sapwood The results of similar studies made by German foresters and botanists are described by M Büsgen and E Münch, in *The Structure and Life of Forest Trees* [1]

The data on which this study is based were compiled by C B Stott, of the Division of State and Private Forestry, United States Forest Service at Milwaukee, Wisconsin, from operations on two tracts of virgin northern hardwood timber in Michigan One of them, in Baraga County, was cut in the summer of 1938, the other, in Iron County, in 1940 These records, which were loaned to the writer for analysis, show the diameter of heartwood, the width of sapwood, and the ages of more than two hundred trees at stump height

The area in Baraga County contained trees of all ages on a site that is poor for sugar maple because of moist soil and inadequate

[1] Pages 121–129 of the translation by T Thomson New York John Wiley & Sons, Inc., 1929

drainage This stand was composed of sugar maple, American elm (*Ulmus americana*), and yellow birch (*Betula lutea*), of equal importance in dominating the site The area in Iron County had trees which seemed to be even-aged This site is better for sugar maple, the dominant species, because it is higher and has better soil

WIDTH OF SAPWOOD

The average width of sapwood at twenty-year intervals was obtained by deducting the average diameter of heartwood from that of the stumps measured The remainder divided by two represented the average width of sapwood that is shown by age groups in Table I

TABLE I

WIDTH OF SAPWOOD AND DIAMETER OF SUGAR-MAPLE STUMPS BY AGE GROUPS

Age group (years)	Timber all-aged, on poor site			Timber even-aged, on good site		
	No of samples	Width of sapwood (inches)	Stump diameter (inches)	No of samples	Width of sapwood (inches)	Stump diameter (inches)
120	14	4 7	13 3			
140	6	4 5	13 6			
160	2	4 3	14 5	2	5 3	13 9
180	14	4 3	16 1	12	5 9	17 1
200	21	4 4	18 2	16	6 7	19 9
220	13	4 7	20 2	16	7 1	21 8
240	16	4 9	22 0	3	7 5	23 3

It is evident that the width of sapwood is greater on the good site and that the greater width reflects the benefits of the better site even more than the sizes of the stumps at specific ages On the poor site the average width was for all practical purposes relatively constant Whether this is caused by the quality of the site or a characteristic of all-aged stands cannot be determined from the information collected The sapwood in the older trees on the good site certainly shows a tendency to be wider This may be due to the ability of the site to furnish water and nutrients in greater amounts as the trees become larger and older, so long as they maintain a dominant position in the canopy

DECREASE IN PROPORTION OF SAPWOOD WITH AGE

It is well known that there is more sapwood in smaller and younger trees The data compiled in the present study and recorded in Table II show this to be true even after trees reach merchantable sizes of twelve inches or more at breast height

TABLE II

PERCENTAGE OF SUGAR-MAPLE STUMP AREA COMPOSED OF SAPWOOD

Age group (*years*)	*All-aged trees, poor site* (%)	*Even-aged trees, good site* (%)
120	91	
140	88	
160	84	94
180	78	92
200	74	89
220	71	88
240	70	87

These data are based on the cross-sectional area of the tree inside the bark at stump height A greater proportion of sapwood is evident in trees on the good site, particularly in the older ones It is reasonable to believe that the younger stands of timber on the more productive areas will contain more sapwood than those on poor sites Lumber from sugar-maple trees grown on good sites will have greater value because it contains more sapwood Although it is admitted that the younger and smaller trees have a larger proportion of sapwood, it does not necessarily follow that they will produce more valuable lumber than larger and older trees in the same stand

INCREASE IN TOTAL AMOUNT OF SAPWOOD PER TREE WITH AGE

The small trees above the sapling stage have in their center many knots and imperfections which are included in the sapwood As they grow older heartwood forms and gradually includes the knots or other defects while the tree annually puts on fresh layers of sapwood next to the bark As the trees mature many of the dead limbs fall off the lower portion of the bole and eventually the sapwood becomes relatively free of knots From then on the lumber from sapwood in mature trees is usually much clearer and freer of

defects than lumber from the sapwood in younger and smaller trees Many lumbermen and foresters fail to appreciate this fact Some become so impressed with the high proportion of sapwood in logs from younger trees that they cannot see that there is usually much more sapwood on the older trees An indication of the manner in which it accumulates is given in Table III, which shows that the basal area of sapwood in the tree at stump height increases as the tree grows older

TABLE III

BASAL AREA PER TREE OF SUGAR-MAPLE SAPWOOD AT STUMP HEIGHT

Age group (years)	*All-aged trees, poor site (square feet)*	*Even-aged trees, good site (square feet)*
120	0 88	
140	0 89	
160	0 95	0 99
180	1 11	1 45
200	1 33	1 93
220	1 59	2 29
240	1 84	2 57

The results are based on observations made of the stumps only That the findings will apply in a general way to the entire merchantable portion of the tree has been established by measurements made at the small ends of more than five hundred sugar-maple logs cut in the Baraga County area The records were compiled by the Forest Products Laboratory at Madison, Wisconsin, in an unpublished report dated February, 1940, and entitled "Alberta Log Grade Study" Although there were no data on ages in this report, it did show the same general characteristics for sapwood on the small ends of sugar-maple logs that have been noted for it at stump height of sugar-maple trees from the area in Baraga County

In reviewing the field records on the observations of the stumps it was apparent that the width of sapwood is affected by factors other than those of age and site Even on the poor site some stumps had sapwood widths of more than eight inches It is likely that the location of a tree in a stand in reference to its competitors for light and soil moisture has a dominant effect upon the amount of sapwood retained by it The combination of all the factors of site affecting a tree controls its rate of growth

AMOUNT OF SAPWOOD AFFECTED BY RATE OF GROWTH

An inspection of the records of the stumps showing the greatest widths of sapwood revealed that they were usually associated with a rapid rate of growth The greater the percentage of sapwood on a stump the smaller the number of years it took to grow one inch in diameter This relation is evident in Table IV, which shows the average of all stumps observed In it the average diameter of the heartwood also is given to show that the formation of heartwood and the reduction of the percentage of sapwood seem to be directly related to the decreasing rate of growth or the greater age of the trees

TABLE IV

GROWTH OF SUGAR-MAPLE SAPWOOD AND DIAMETER OF HEARTWOOD

(*Poor site, Baraga County, Michigan*)

Age group (years)	No of years to grow one inch	Percentage of stump area in sapwood	Diameter of heartwood (inches)
120	13 6	91	3 9
140	15 4	88	4 7
160	17 0	84	5 9
180	18 1	78	7 5
200	18 4	74	9 3
220	18 5	71	10 8
240	18 6	70	12 1

From the material in Table IV alone it seems reasonable to believe that, if the growth rate is kept high, a large proportion of sapwood can be retained in a tree, and an inspection of the records of individual trees indicates some basis for this opinion Since second-growth stands have a high rate of growth and are not likely to reach the advanced age of our virgin forests of the past, one can expect higher percentages of sapwood in the next cut of sugar-maple trees of the northern hardwood forests By maintaining these stands in a highly productive condition there will be even greater proportions of maple sapwood lumber in the future

CONCLUSIONS

1 The width of sapwood was noted to be relatively constant at 4 5 inches in an all-aged stand on a poor site, regardless of the age

of the tree On a good site and in an even-aged stand, however, the width of sapwood was greater, particularly on the older and larger trees

2 The proportion of sapwood is greatest in the smaller and younger trees on both good and poor sites

3 The total amount of sapwood per tree is greater in the larger and older trees

4 The amount and width of sapwood are greater in the trees which have the highest rate of diameter growth Foresters will therefore increase the production of sapwood in sugar-maple trees in the future by managing them so as to secure high rates of growth

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PUBLIC FOREST HOMESTEADS

HENRY GILBERT WHITE

THIS paper deals primarily with the timber workers and settlers of the cutover region of the northern Lake States and with a program for improving their standards of living Many of them are existing in the most abject poverty, in the midst of forest land and timber resources which, if properly handled, could supply them with an adequate income A plan for Public Forest Homesteads is here proposed to help solve this problem It is so called because it borrows what was good in the rugged, self-reliant life of early American homesteaders and adapts it to modern industrial society, where the individual cannot stand alone but must find security under public guidance

In analyzing the viewpoints and experience which provide the setting for this plan it is necessary to go back into early United States Forest Service history The conservation movement in the United States, which in the beginning was identical with the forestry movement, has always had broad humanitarian objectives Since its transfer to the Department of Agriculture in 1905 the guiding principle of the Forest Service has been "the greatest good of the greatest number in the long run "[1] But this has been a long-term, nation-wide goal which has often drawn attention away from the immediate needs of local people for jobs and for timber products Although the theory that the public forest should not be "locked up" for the sole use of future generations was accepted,[2] most of the early effort of the Forest Service was necessarily spent in protecting the forests from fire and illegal cutting As rapidly as the pressure of other work allowed, it put into effect timber-sale and grazing policies permitting the maximum of private use not inconsistent with the interests of the general public The enforcement of these policies

[1] Cameron, Jenks, *The Development of Governmental Forest Control in the United States*, p 240 Baltimore The Johns Hopkins Press, 1928

[2] Pinchot, Gifford, "How the National Forests Were Won," *American Forests and Forest Life*, 36 (1930) 616

often meant conflict even with local people until they became accustomed to the advantages of rules that prevented the destructive exploitation of the resources

One of the first real tests of Forest Service policy came with the passage of the Forest Homestead Act of 1906 [3] This law was designed to correct injustices caused by the inclusion of agricultural land within Forest Reserve boundaries Many western people had protested against the closing to settlement of this tillable land Those with perfected titles to homesteads in the Forest Reserves complained of being denied neighbors on adjacent treeless land Those with squatter rights found that they could not perfect their homestead titles because the surveying of lands in the Forest Reserves had been delayed in favor of needed surveys elsewhere

The Forest Homestead Act of June 11, 1906, familiarly known as the "June 11" law, attempted to meet these criticisms by opening to homesteading any areas within the Forest Reserves which, on application to the Secretary of Agriculture, were determined to be "chiefly suitable for agriculture and might be so used without injury to the forest reserves" It was a just and well-drafted bill, but few anticipated the homestead hysteria and land-speculation fever that it released

Within a short time after the passage of the "June 11" law thousands of applications for homesteads were filed with the Secretary of Agriculture Probably a majority of them were not made in good faith, with the idea of tilling the land, but were attempts by private individuals and lumber companies to get title to valuable timberland Nevertheless, each application was carefully appraised by the Forest Service in order not to prejudice the claims of legitimate settlers It was a tremendous task of land zoning that had to be done under pressure of time and of individuals and groups with great political power The Forest Service can justly be proud of the manner in which it handled this first real attempt at detailed land classification in the United States [4]

Only five years after the passage of the "June 11" law the Forest Service was faced with the problems of unwise agricultural

[3] 34 Statutes at Large of the United States, 233

[4] Sherman, E S, "'June Eleventh' and Homestead Hysteria," *American Forests and Life*, 36 (1930) · 409, Ise, John, *The United States Forest Policy*, pp 164–168, 254–261 New Haven Yale University Press, 1920.

use of mountain land in the eastern and southern states The Weeks Law of 1911[5] authorized the establishment by purchase of national forests east of the Mississippi Often this meant buying up cultivated hillside farms and dispossessing the occupants What happened to these people after their homes and lands were sold to the Government was not a primary concern of the Forest Service at that early date According to the prevailing theory, it was assumed that they could and would seek better economic opportunities elsewhere

It is not strange that the Forest Service, on the basis of these experiences, had a strong defensive complex against those who attempted to invade the pristine domain of the national forests Settlers were expected to earn their entire income from farming Widespread unemployment, agricultural depressions, and the full effect of disappearance of the western frontier had not yet suggested the need for more intensive use of the public forests to support destitute forest workers and settlers

A similar policy of classifying land for its best use and, if that proved to be forestry, of moving the settlers out or, at least, of preventing further settlement, was later advocated and adopted in state and county land-zoning laws The Wisconsin legislature passed the first rural land-zoning law in 1923 Its original purpose was to give the counties control over suburban land development The authorization for counties to regulate the use of land for agriculture, forestry, and recreation was enacted in a 1929 amendment The first county zoning ordinance under this amendment was adopted in 1933[6] A few other states have similar zoning laws, but they have made less progress than Wisconsin[7]

Rural zoning represents a very worth-while trend, with one important limitation. It assumes that settlers have only one objective and one source of income — farming The need for part- or full-time forest workers and for homes for them in the forest has been entirely ignored The zoning ordinance of Florence County,

[5] 36 Statutes at Large of the United States, 961

[6] Rowlands, W A, and Trenk, F B, *Rural Zoning Ordinances in Wisconsin*, pp 3–6 Circular No 281 of the Extension Service of the College of Agriculture of the University of Wisconsin, July, 1931

[7] Walker, Herman, *Problems and Suggestions in the Drafting of Rural Zoning Enabling Legislation*, pp 4–7 Land Use Planning Publication No 10 Resettlement Administration, Washington, D C, December, 1936

Wisconsin, reveals this deficiency [8] It provides for three classes of use forestry, recreational, and unrestricted No family dwellings may be built in districts zoned for forestry In the other two classes family dwellings are allowed Thus a woods worker or part-time forest guard who must live near his work may be hard pressed to find a home site in an adjacent recreational or unrestricted district If he secures such a site in a recreational district, he is prohibited from clearing land and farming He must make his entire living from forestry work or recreation and, unless there is some wild-hay land available, he must buy all the feed for the horses he may need for logging and other work

This situation may seem sensible to those who think of forestry in terms of reserving the forests for the use of future generations, but it does not conform to past experience or present-day needs Throughout the history of the lumber industry in the Lake States logging has usually not been a full-time job Many of the early lumberjacks had farms on which they worked during the summer months with the idea that they would eventually become full-time farmers But experience has proved that a large number of the northern farms will never become self-sustaining Their owners will always have to rely on woods work or other jobs to supplement their income

In Sweden, where systematic forest organization has progressed further than in this country, the need for homesteads for woods workers located in or near public forests has long been recognized As early as 1891 provision was made for leasing of homesteads to forest workers in one of the northern forested provinces Each homesteader was given timber, free of charge, for building and other purposes, and also a grant of money During the early part of each lease the homestead was rent- and tax-free In return the homesteader was obligated to make good use of the site, serve as a forest guard, and work in the woods at the current wage [9]

With certain modifications this system of encouraging settlement in northern forested Sweden has continued up to the present day A royal decree of 1925 provided that homesteads should be granted only where "there is considered to be available supple-

[8] Rowlands and Trenk, *op cit*, pp 34–39

[9] The Royal Social Board, *Social Work and Legislation in Sweden*, Second revised English edition, pp 273–275 Stockholm Tryckeriaktiebolaget Tiden, 1938

mentary work to enable the settler and his family to obtain the necessary subsistence The settler is allocated 8 to 17 hectares of cultivable land, and besides as large an area of forest land as, with ordinary care and good management, will suffice to produce an annual supply of 15 to 20 cubic metres of timber The lease is granted for 15 years During the first ten years the settler is exempt from the payment of rent he enjoys certain grants from the State with no obligation to refund

"For the buildings of his holding, the settler receives from the State a building grant of up to 3,500 kronor, in certain exceptional cases as much as 4,500 kronor As a rule the settler himself takes in hand the erection of the buildings, but in certain cases the State takes charge of the work Furthermore, the settler receives, free of charge, the building timber he requires, together with necessary fuel " [10]

In the United States the demand for full development of employment opportunities on public forests was not widely expressed until the depression years following the market crash of 1929 During these years foresters were among the first to invite the use of destitute settlers and unemployed workers in planting and improving devastated forest lands In the beginning this solution of the problem was considered a temporary expedient for the relief of these people until their former sources of income should commence to flow again Where the relief workers lived during this period was of no great concern to public officials But as the need for relief work on the forests stretched from months into years it became apparent that the temporary government camps, the dilapidated cabins, and the tar-paper shacks which housed them were just as great a bar to their permanent rehabilitation as was the lack of an assured source of income

In the forests of the northern Lake States several moves were made to establish permanent homesteads and improve existing ones for people needing relief A comprehensive plan was prepared by the Forest Service in 1935 for the settlement and relocation of submarginal farmers and unemployed people on small tracts of farm land in or near the national forests [11] It provided for loans and tech-

[10] *Ibid*, pp 275-276

[11] Camp, John R, *A Plan for Social Adjustment for the Forest Areas of the North Central States, with Special Reference to the National Forests* United States Department of Agriculture, Forest Service, 1935 (*Mimeographed*)

nical assistance in building up adequate homesteads It was not expected that many of the settlers would be able to earn their whole living from farming, it was thought that most of their cash income would be derived from forestry work on the national forests Homesteads were to be purchased over a long period of years through deductions from their cash earnings The plan suggested that in some cases leasing of the homesteads rather than outright purchase would be advisable because it would place less of a burden on the settler and would provide a check on the wise use of the land

The execution of this plan, at least in its entirety, was dependent, however, on large emergency relief appropriations, which were never forthcoming It must be said to the credit of the Forest Service that, although appropriations were lacking for executing the 1935 plan, a number of less ambitious schemes for aiding the people of certain localities have been undertaken

The Drummond project[12] on the Chequamegon National Forest in northwestern Wisconsin took some of the unemployed woodsmen and "shackers" left in the wake of a large-scale destructive logging operation, put them in new homes in a little forest community, and gave them part-time jobs in forestry work Two important lessons were learned from this project (1) that building houses with relief labor is expensive unless part of the cost is charged directly to relief, and (2) that forest communities should not be developed where there is little or no commercial timber unless no alternative exists or there is reasonable assurance of appropriations over a long period of years for planting and other forest-rehabilitation work The ultimate goals should be self-liquidation of the investment in buildings and forestry work and self-sufficiency or financial independence of the homesteader

The Chippewa National Forest of north-central Minnesota is better supplied with merchantable timber than the Chequamegon, and so has been able to inaugurate a program of reëmploying and rehabilitating settlers on an informal, cooperative basis The first step has been to coordinate forest-management plans with the employment needs of the local people Wherever possible, timber sales and forest-improvement work are allotted to local settlers The Forest Service also assists by land exchange in the relocation of

[12] Other divisions of the United States Department of Agriculture as well as the Forest Service participated in this project

settlers on better farm land closer to opportunities for work and community services

Now that the Chippewa, Drummond, and other projects have tested the prospects and methods of rehabilitating the people of substandard income in the cutover region, the time seems ripe to inaugurate a plan for meeting and solving these problems on a permanent, region-wide basis Several organizations[13] have recently attempted to focus public and legislative attention on the problems of the cutover region and the steps that might be taken to solve them The Northern Lake States Committee report[14] shows that a decade of depression, relief appropriations, and desperate striving for recovery has not obliterated the effect of many decades of destructive exploitation of resources If action does not result from these committee recommendations, it will be because their plans are not geared to fit present governmental trends, for many of them require larger relief appropriations than can possibly be obtained at the present time, when national and even local emphasis is shifting to military defense

Artificial stimulation of business by defense expenditures may bring temporary prosperity to the extractive industries of the northern Lake States Some of this money will trickle down to the woods workers and millmen, but very little of it will reach the submarginal settlers And when defense activities slacken the northern Lake States region may face a greater depression, with its resources more gutted than before

This, then, is the time to adjust the economy of the region to withstand the shocks of industrial collapse The region must tackle that problem in the face of declining relief appropriations It has two resources with which to work an abundance of forest land — poorly stocked, to be sure; and manpower, with its strength sapped by years of underemployment, but still lit with a spark of hope for a better way of life

The plan here proposed to meet the challenge of this emergency is called "public forest homesteads" because it adapts the best fea-

[13] The Northern Lake States Regional Committee of the National Resources Committee and a Facilitating Interbureau Coördinating Committee of the United States Department of Agriculture

[14] *Regional Planning, Part 7 — Northern Lake States* Report of the Northern Lake States Regional Committee to the National Resources Committee Washington Government Printing Office, 1939

tures in the life of the rugged pioneer homesteader to the requirements of the present day Perhaps the name does not fully describe the comprehensive method by which the forest resources and industries of the region must ultimately be rebuilt to contribute most to the welfare and security of the local people But it does indicate the central idea of providing permanent homes for woods workers who will protect and improve the forest and find security and happiness in a forest economy

The essential features of the plan are these

1 Local unemployed or underemployed people who are inadequately housed and have no land would be leased small tracts of tillable land (where available) and supplied with timber and other building materials at cost, often in exchange for labor, with which they could build themselves satisfactory homes Settlers adequately supplied with land but with unsatisfactory buildings would be aided with building material and loans [15] Settlers located inconveniently far from work opportunities and community organization should be relocated by land exchange, but not with the idea of depopulating the forest, upon which most of them are dependent for their cash income In one way or another every settler should be provided with enough tillable land on which to grow much of the food needed for his family and his livestock Although the cost of a subsistence homestead built up chiefly with a man's own labor should not be great, it would be unwise to require all settlers to buy their homesteads from the Government if they do not wish to do so or are financially unable A long-term low-rate lease, terminable for good cause, would protect the rights and interests of both the lessee and the lessor — the latter being the Government in most cases

2 Sufficient forest land should be dedicated to the use of each homestead or forest community to supply employment in harvesting the timber and to provide wood for home requirements

Owing to the varying conditions and resources of each locality considerable flexibility would be necessary in budgeting available employment In areas where the forests have been so thoroughly exploited and burned that there is little commercial timber left the public would have to continue to make long-term investments in

[15] On most public forests there is some timber of little value for sale or as growing stock which could properly be used for homestead construction.

planting, fire protection, and other forestry work In many areas there are adequate timber resources to expand employment in timber cutting if new markets and new industries can be developed which are adapted to the kinds of second-growth timber available

A recent estimate places total additional employment needs in the cutover region at 60,000 man-years, including urban as well as rural workers [16] The full burden of supporting all these people cannot properly be placed on the forest resources of the region, but scientific forest management can ultimately find jobs for many of them In parts of Europe where intensive forestry is practiced the time of one man is required on each 100 acres Forestry cannot be practiced on such an intensive scale in the Lake States But if at present only one man per 1,000 acres could be given full-time work the national forests of the region, which cover nearly 6 million acres, should be able to maintain 12,000 homesteaders on half-time work If state and county forests (containing over 12 million acres) were also managed on this basis, 24,000 homesteaders would be provided for There is also no reason why private timber owners could not employ forest homesteaders to advantage No attempt at an exact forecast is here made, but these figures indicate the potential capacity of the forests of the region to provide productive work

3 In the long run public forest homesteads should be conducted on a self-liquidating basis Cash income would be derived primarily from timber and other forest products It is clear that, when the forests are in production, the homesteaders are going to be badly needed for protection and improvement work and for timber cutting

The immediate costs of this program would depend on how rapidly it is put into operation The heaviest expense would be incurred during the first few years in supervising homestead development and, when jobs are scarce, in providing employment on conservation projects It would certainly not cost any more to establish and maintain a family on a forest homestead than it does to hire, equip, and supervise one Civilian Conservation Corps boy Many of these families are receiving relief money anyway, and so the cost would not be any greater if they were employed on forestry work, in which there is some prospect of liquidating the investment

[16] Peterson, Lyall, "A Permanent Solution to Unemployment and Relief Problems in the Northern States through Forestry Measures" July, 1940 Unpublished manuscript.

4 The resettlement and reëmployment program on the Chippewa National Forest has shown that little new federal authorization would be needed to carry out a similar plan on a broader basis There is already available within the Department of Agriculture most of the machinery for land exchange, farm-improvement loans, free-use (timber) permits, sales of timber at cost, small timber sales, and so on Past advances have been limited by lack of a clear-cut program and the personnel to push it However, a federal forest homestead act which would establish an active policy toward local settlers and clarify the authority of forest officers would serve a useful purpose The states and counties need not only policy-forming legislation, but also additional funds and personnel if their forests are to be placed under constructive management for the benefit of the local people

5 The Drummond project in Wisconsin has proved that the rehabilitation of forest workers cannot be entirely successful unless it is done as part of a larger scheme to develop the forest resources and timber markets to their full capacity Thus a supplemental program would be vital to the success of the public forest homestead plan Such a program should include the following elements [17]

(*a*) Encouragement of cooperative logging, milling, and marketing of forest products in order to increase the efficiency and bargaining power of small logging and milling operations which have been so prevalent in the Lake States in recent years

(*b*) Government logging should be authorized where mature and overmature timber is available, but sales of stumpage are not bringing the volume and stability of employment needed by local woodsmen This is not so radical a thing as might at first appear In Europe the harvesting process has always been considered simply a phase of the job of growing timber, just as the farmer considers harvesting a part of his job That government-logged timber would glut the lumber market need not be feared if it goes into construction of forest homesteads, into new industries, and into low-cost housing according to the plans outlined under (*c*) and (*d*) below

(*c*) New industries capable of using low-grade second-growth timber should be encouraged by research, low-interest loans, and gov-

[17] White, H G, "How Forestry Can Help to Solve the Unemployment Problem" Statement prepared for Congressional Committee on Unemployment, Seventy-sixth Congress

ernment pilot plants As more and more big sawmills close down owing to exhaustion of old-growth timber and inability to operate on smaller timber there are going to be real opportunities for the development of new industries

(*d*) During recent years both urban and rural home construction and repairs have lagged far behind normal requirements This means that many people are living in unsanitary tenements, obsolete homes, and flimsy shacks The construction industry, even with present federal assistance, has failed to tap this huge market for low-rent and low-cost houses [18] Most low-income groups have idle time which could be put into home construction A self-help housing program for both farmers and city dwellers is needed to meet this situation

(*e*) In the long run, everything which builds up the forest resources and leads toward sustained-yield management of private timber holdings will increase the volume and stability of employment For this reason every effort should be made to extend public ownership and control over as much as possible of the private timberlands that are not being properly managed Public regulation of cutting practices should also be adopted in order to prevent continuation of destructive logging and, consequently, the further aggravation of the problem of idle forest land and idle woods workers Those private land owners who have demonstrated their willingness and ability to manage their timber on a permanent basis should be given every encouragement But if they require such large public subsidies that the Government has to put in as much money as would be required to buy the land, the land might as well be placed under Government ownership in the beginning, so that the public interest will be fully protected

One should be suspicious of any simple panacea prescribed for the complex social and economic ills of a cutover region such as the Lake States The establishment of public forest homesteads alone will not be enough But if the problems of the region are attacked concurrently along all the fronts indicated above there is hopeful prospect for development of a stable and prosperous forest economy The attack must be integrated It must be centered on immediate

[18] *Investigation of Concentration of Economic Power Part XI, Construction Industry* Hearings before Temporary National Economic Committee, Seventy-sixth Congress Washington Government Printing Office, 1940

needs The public forest homestead plan supplies that unified approach, for it reduces the problems of the people to two basic elements — the need for a home and the need for forest land from which to earn a permanent livelihood The plan, then, seeks directly to supply those missing elements

United States Forest Service
St Paul, Minnesota

ZOOLOGY

ALABAMA SPIDERS OF THE FAMILY MIMETIDAE

ALLAN F ARCHER

IN 1939 and 1940 I collected an extensive series of Mimetidae in Alabama while making an inventory of spiders under the auspices of the State Department of Conservation The members of this family are of interest on account of their habits, habitats, and distribution Only two genera, *Mimetus* and *Ero*, are known to occur in Alabama *Mimetus* preys exclusively on spiders, many species of which are useful in controlling insect populations Little information is available about the prey of *Ero*

The family Mimetidae may be described briefly as follows three claws, the first and second tibia and metatarsus provided with a row of long spines, the interspaces between which are occupied by a row of much shorter spines [1] The chelicerae lack a boss (lateral condyle), and the palpus of the female has a terminal claw Petrunkevitch [2] places the Mimetidae in the group of three-clawed spiders (Trionychae), close to the Archaeidae, Palpimanidae, and Uloboridae, but interposes between this group of families and the Argiopidae a whole series of families, such as the Amaurobiidae, Agelenidae, and Lycosidae I do not believe that the present evidence warrants this arrangement, and I prefer to follow Bristowe,[3] who classes the Mimetidae close to the Argiopidae in the upper rank of Ecribellatae

The two Alabama genera may be separated as follows

1 Legs I and II much longer than legs III and IV, clypeus definitely shallower than the ocular region *Mimetus*
2 Legs I and II very little shorter than legs III and IV, clypeus not shallower than the ocular region *Ero*

In general, the species of *Mimetus* are of greater stature than those of *Ero*, and are a little slower in their locomotion *Ero* apparently makes a web, but *Mimetus* is not known to do so

[1] There are some departures from this arrangement of spines in certain exotic genera

[2] Petrunkevitch, A , *Trans Conn Acad Sci* , 33 144, 160–161 1940

[3] Bristowe, W S , *Proc Zool Soc London*, 108 Part 2, 285–321 1938

MIMETUS HENTZ, 1832

The author of the genus *Mimetus* at first believed its web combined features of the webs of *Aranea* and *Theridion*. He based his belief on the fact that his first specimen was found in the web of *Metepeira labyrinthea* (Hentz), which makes a web of exactly this type. The epigynum of the females of *Mimetus* is in the form of a caudally projecting chitinized lobe. The male palpus has a chitinized cymbium. This genus is widely distributed in Alabama, but fortunately for the spiders which fall prey to the several species, they are not very abundant in any one locality. Although generally slow in its movements, each spider displays great cleverness in stalking its quarry. Apparently its invasion of a nest or retreat usually takes the occupant by surprise. Even when the inhabitant is on guard it attacks aggressively, and is quite capable of killing spiders larger than itself. When protecting its eggs it keeps very quiet, with its legs drawn up. Not infrequently the female remains in the web of her victim, and lays her eggs in it. On a number of occasions I found, much to my amazement, gravid females of *Mimetus* occupying nests of other species of spiders.

In 1923 Chamberlin[4] completely revised the North American species of *Mimetus*. Since then several more species have been described. We now have a large series of locality records from both Alabama and Texas. The Alabama series has enabled me to clear up certain doubtful matters, particularly the correlation between color patterns and the identification of species, which is based on Chamberlin's study of the genitalia. Although there is a certain amount of variation in the color pattern of each species (especially in the males), the limits of variation are rather definite. Chamberlin found that there are two common species in the southeastern states. He determined the identity of one of them, *M. interfector*, on the basis of the male and the palpus, as shown by Hentz,[5] Plate 15, Figure 13. The color pattern and the external morphology of the female in Figure 12 show that it is not of the same species as the male in Figure 13. Since it is the right of the first reviser to fix the species in question and since there is no such thing as figure priority,

[4] Chamberlin, R. V., *Journ. Entomol., Pomona College*, 15: 3–6, figs. 1, 6. 1923.

[5] Hentz, N. M., *Journ. Boston Soc. Nat. Hist.*, 6: 3. 1850.

Chamberlin's decision must stand The immature male shown in Figure 14, *M tuberosus* Hentz, should be considered a synonym of *M interfector*, and this is in accordance with Chamberlin's opinion Finally, the female shown in Figure 15, *M syllepsicus* Hentz, belongs with the male of Figure 13 It is fortunate that the ample series of female *interfector* from Alabama clearly establishes the fact that *syllepsicus* is a synonym of *interfector* In a later section I shall designate neotypes of each of these synonyms in order to clarify their position

In the species of *Mimetus* treated below a record from Florida and another from a county in Georgia are included, since each of these areas is close enough to the boundary of Alabama to furnish additional evidence of distribution of the species

Mimetus puritanus Chamberlin

Mimetus interfector Hentz (in part), Journ Boston Soc Nat Hist, 6 pl 4, fig 12 1850

Mimetus interfector Emerton (nec Hentz), Trans Conn Acad Sci, 6 16, pl 3, fig 3 1882

Mimetus puritanus Chamberlin, Journ Entomol Zool, Pomona College, 15 3–6, figs 1, 6 1923

Morphology — The general ground color of both sexes is pale yellow or dirty white The color of the folium on the dorsum of the abdomen of the female is quite solid, being plain brown or tinged with purple The border of the folium is a serrated black line, and there are two comma-like pale or white marks between the shoulders The caudal side of the shoulder humps may or may not have a white zone The carapace is ornamented with thick brown or black double-Y-shaped lines, the apices of each Y reaching the ocular tubercles and the inner branches of the Y's joining behind the posterior median eyes The right and left external zones of the carapace are each ornamented with a dot The epigynum is broad caudally and unusually stout, and the aperture is visible from the ventral side The outer margin of the cymbium of the male palpus has two spines located proximad of the apical one, a position not found in the other species

Type locality — Ithaca, Tompkins County, New York

Distribution — Alabama· Baldwin County, Dyas Creek, females; Dale County, Ariton, male, Morgan County, Cave Spring Cave, females. Georgia Muscogee County, Upatoie Creek, female

This species is distributed throughout the Appalachian Highlands In Alabama it occurs only occasionally, and is present not merely in the Cumberland Plateau and the Piedmont, but also in the lower portion of the Coastal Plain Both *puritanus* and a number of other spiders of known Appalachian distribution appear to have extended their ranges into the Coastal Plain from the Piedmont by way of the Chattahoochee and Pea river valley systems

Ecology — This species is found on the under surfaces of the leaves of gallberry (*Ilex glabra*), holly (*I opaca*), and various other evergreen and deciduous shrubs It has also been seen in impressions in the overhangs of ledges near the mouth of a cave It occurs in ravines having hardwood and hardwood-coniferous cover, as well as in flat woods, particularly of the loblolly- and longleaf-pine types It is not known from uplands In one locality it was observed inside an old building The information available in my field notes indicates that *puritanus* attacks two species, *Tidarren fordum* (Keyserling) and *Theridion tepidariorum* C L Koch

Mimetus interfector Hentz

Mimetus interfector Hentz (in part), Journ Boston Soc Nat Hist, 6 pl 4, fig 13 1850

Mimetus tuberosus Hentz, *ibid*, p 3, pl 4, fig 14 Neotype, Alaga, Houston County, Alabama, male, August, 1940 Archer collection, Alabama Museum of Natural History

Mimetus syllepsicus Hentz, *ibid*, p 34, pl 4, fig 15 Neotype, Randon's Creek, Monroe County, Alabama, female, April, 1940 Archer collection, Alabama Museum of Natural History

Mimetus interfector, Chamberlin, Journ Entomol Zool, Pomona College, 15 3–7, figs 5, 9 1923

Morphology — The general ground color of both sexes is nearly white or, occasionally, faintly green The folium on the dorsum of the abdomen of the female usually consists of a broad black disk beginning at the pedicel and extending back to the shoulders, from there it may or may not reach the apex The folium of one female is in the form of an irregular mass of wavy broken lines and red spots Its abdomen is broader proportionately than that of either *M puritanus* or *M notius* The shoulder humps or horns are quite prominent, except in gravid females The abdomen of the male is ovate, and the dorsal pattern is rather variable In some males the pattern may consist of four large spots, but in other males the folium is marked by a series of irregular brown or black lines, and there may be a dis-

tinctly serrated border One or more pairs of pale spots may also be present on the folium The carapace of both sexes has a bifurcated black or brown line united anteriorly and posteriorly, usually with a longitudinal bar The pattern of the female may be very broad and irregular in its posterior extension, and there are often a pair of black dots behind the posterior median eyes and a pair on the external lateral region of the carapace The chelicera is black from the fang one third to more than one half the way back to the base The labium has a pair of dots

The epigynum is rather elongated, with the sides a little more parallel than they are in the other two species The aperture is not visible from the ventral view It is partly divided into a distal and a proximal portion by lateral processes The cymbium of the palpus of the males terminates apically in a very prominent spine, and the apex of the bulb bears two lobes The anal tubercle is small

Type locality — Male neoholotype and female allotype, Tuscaloosa, Tuscaloosa County, Alabama, October, 1938, January, 1939 Archer collection, Alabama Museum of Natural History Hentz lived in Tuscaloosa from 1842 to 1846, and it may have been in this locality that he collected the male on which the species is based

Distribution — Alabama Baldwin County, Jackson Oak, female, Magnolia Springs, male, Coosa County, Hatchet Creek, females (rather frequent), Houston County, Alaga, immature specimens, Omussee Creek, female, Jefferson County, Birmingham (R V Chamberlin), Monroe County, Randon's Creek, female, Shelby County, Morgan Station (R V Chamberlin), Tuscaloosa County, Alberta City, female, Tuscaloosa, females and males (frequent) Florida Calhoun County, Bristol, females and males This species is known from the southern two thirds of the state

Ecology — The spiders are found on the under surfaces of the leaves of holly, laurel (*Kalmia latifolia*), stinking bay (*Illicium floridanum*), bay (*Magnolia glauca*), and bull bay (*M grandiflora*), hydrangea, and ironwood In the winter it prefers evergreen shrubs, except when stalking its prey It is also found under high hedges, and it invades the basements of houses The preferred situations are hardwood, hardwood-coniferous ravine areas, and lowland woods I have observed it preying on some of the following spiders *Tidarren fordum* (Keyserling), *Theridion tepidariorum* C L Koch, *Metepeira labyrinthea* (Hentz), *Aranea miniata* (Walckenaer), *A pegnia* (Wal-

ckenaer), and several species of *Dictyna* Its egg sacs are roughly oblong and are fastened to the web of a theridiid or argiopid spider

Mimetus notius Chamberlin

Mimetus notius Chamberlin, Journ Entomol Zool, Pomona College, 15 3-5, 7, figs 4, 10 1923

Morphology — The ground color of both sexes is pale yellow The folium on the dorsum of the abdomen of the female is a mass of curved, wavy, or zigzag black lines, with some red markings interspersed, especially in the region of the shoulders It is sometimes bordered by a deeply serrated line A white mark is often present on each of the shoulders The shoulder humps are very elevated in the females In the male the pattern may be very much like that of the female or it may be merely a series of dots on a brown background The carapace has a group of variously branching black lines The anterior portion of the pattern is W-shaped, each apex terminating close to the ocular tubercles The distal end of the chelicera is black, but the color does not extend far proximad, the rest of the chelicera is brown It must be borne in mind that there are some exceptions to the patterns described above

The epigynum is very wide at the base, rather short, and bluntly narrowed apically The aperture resembles that of *interfector* in not being visible from the ventral view, but differs in not being armed with teeth The cymbium of the male palpus is terminated by a short, wide curved spine, but the apex of the bulb bears only one lobe

Type locality — Runnymede, Osceola County, Florida, R V Chamberlin

Distribution — Alabama Baldwin County, Bay Minette, females, Dyas Creek, females, Hog Creek, female, Cherokee County, May's Gulf, female, Cleburne County, Cheaha State Park, females, Covington County, Red Level, immature specimens; Escambia County, Brewton, female, Little River State Park, female, Geneva County, Panther Creek State Park, female, Hale County, Prairieville, females and male, Houston County, Dothan, females and male (frequent); Jefferson County, Cooley Creek, immature specimen, Lee County, Chewacla Creek State Park, females, Mobile County, Satsuma, female, Spring Hill, immature specimen, Mobile, female (H P Loding), Montgomery County, Waugh, female, Tuscaloosa

County, Tuscaloosa, female and male This species has been found over most of the state except in the region of the Tennessee Valley

Ecology — This species is found on the under surface of the leaves of evergreen shrubs in swamp woods (red gum, tupelo), in ravine woods on laurel and huckleberry, and in upland woods (pine, black-jack oak, turkey oak) on yaupon (*Ilex vomitoria*), gallberry, and pin oak (*Quercus laurifolia*) It is present in longleaf-pine areas On the whole, *M notius* is not partial to any single habitat complex, and it is in dry upland country It is quite common in red-cedar thickets on chalk prairies It also invades buildings I have noted it particularly in cabins in state parks and in tourist camps, as well as on picnic tables

I have observed *M notius* preying on some of the following species of spiders *Theridion tepidariorum* C L Koch, *T spirale* Emerton, *Latrodectus mactans* (Fabricius), *Tetragnatha laboriosa* Hentz, *Metepeira labyrinthea* (Hentz), *Aranea pegnia* (Walckenaer), and *Eustala anastera* (Walckenaer)

Mimetus tillandsiae, sp nov

Carapace elongate-cordate and having black spines, one posterior pair preceded by two sets of three spines, one spine behind PLE, one spine between PLE and PME, one pair between PME and AME Carapace pearly, with ruddy margins Legs and appendages waxy Legs having the stout spines buff and the typical arrangement Palps spinose Sternum two thirds as wide as long Coxae I and II close together, III and IV close, IV well separated from each other Abdomen oval and lacking humps, scattered hairs present Dorsum of abdomen with chalky lateral stripes and a central longitudinal stripe, two olivaceous stripes interposed, surmounted with hairs, bases of these hairs red, a basal black spot, a premedian lateral spot on each olivaceous stripe and followed by three similar spots in the apical region. Length 5 0 mm Legs, 1-2-4-3 arrangement, I pair, femur 1 0 mm, tibia 3 9 mm, tarsus 4 0 mm, metatarsus 20 mm

Epigynum as illustrated in Figure 1 Pit on dorsal surface not visible except in caudal view Aperture having three denticles on caudal border, oval, and with a black border, no dorsal strip apparent Caudal end of epigynum faintly indented toward the lateral borders Spermathecae long, not noticeably constricted at the

isthmus, the anterior and caudal ends diverging This species contrasts with *M hesperus* Chamberlin in the internal structure of the epigynum and in having more nearly parallel sides The abdomen is more nearly oval and the longitudinal markings contrast with the transverse black lines that occur in the few specimens of *M hesperus* that I have seen

Type Locality — Female holotype, Allandale, Volusia County, Florida, December 30, 1940 Female (immature) paratype, Jackson Oak, Baldwin County, Alabama, January 17, 1941 Archer collection, Alabama Museum of Natural History

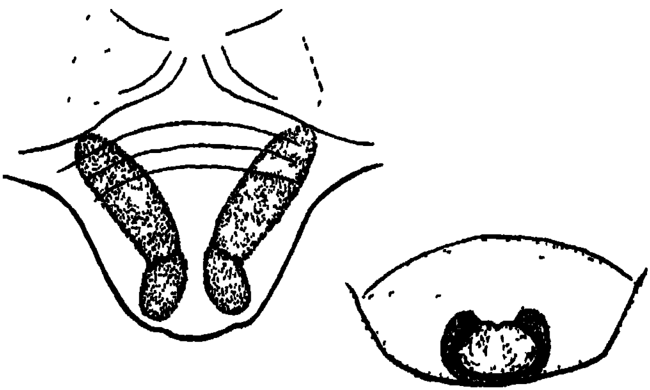

Fig 1 *Mimetus tillandsiae* Allandale, Volusia County, Florida

In both localities this species was taken in Spanish moss (*Tillandsia usneoides*) in hammock woods It seems to prey on *Eustala anastera* (Walckenaer) and other species

The seasonal distribution of Mimetus — Adult females and males of two of the four species in Alabama have a rather wide seasonal distribution The seasonal data are as follows

M puritanus June, ♀ ♂, July, ♀ ♂

M interfector January, ♀ ♂, March, ♀, April, ♀, June, ♀, July, ♂, October, ♂, December, ♀

M notius May, ♀ ♂, June, ♀, July, ♀, August, ♀, September, ♂, October, ♀ ♂, November, ♀

M tillandsiae December, ♀.

ERO C Koch, 1837

The genus *Ero* is represented by three known species in Alabama Although it is very uncommon, enough specimens have been collected to indicate that it has a state-wide occurrence In the Tennessee Valley it appears to be more widely represented than *Mimetus* There is evidence that all three species construct some sort of web or shelter, but the web is very simple and small I have no data on the prey of spiders of this genus, but on two occasions I found wandering individuals close to the web of species of *Lephthyphantes* (linyphiid spiders) Comstock[6] states that the egg sacs are nearly spherical and are suspended by a string of coarse threads which envelop them

The female genitalia of *Ero canionis* Chamberlin and Ivie have never been described Although this species is known only from the northern Appalachian Highlands and the Rocky Mountains, it seems advisable to include it with the Alabama species in the following key

1 Epigynum a single prominent, bilobed, heavily chitinized mass, the vulva obscured by a lidlike projection, the surrounding area above the epigynum not clothed by long hairs *Ero lodingi*

1 Epigynum not prominent, bilobed, or heavily chitinized, the area above the epigynum clothed by scattered hairs 2

2 Epigynum simple, spermathecae visible, not being obscured by chitinous plates 3

3 Spermathecae shaped like fishhooks, the short terminations facing each other, and less than a diameter apart, caudal margin of epigynum rimlike *Ero canionis*

3 Two large circular holes, one diameter apart, on either side of a central plate, each extending into a diverging spermatheca *Ero pensacolae*

2 Epigynum complex, having a small central plate, roughly kidney-shaped, deeply incised in the center, each lateral wing of the central plate bordered by a chitinous diagonally placed lappet *Ero furcata leonina*

Ero furcata leonina (Hentz)

Theridion leoninum Hentz, Journ Boston Soc Nat Hist, 4 277, pl 9, fig 12 1847

Ero thoracica Emerton Trans Conn Acad Sci, 4 18, pl 3, fig 5 1882

Morphology — This species has a pair of dorsal tubercles on the abdomen and resembles *E canionis* in this respect and also in coloration The American species has been considered identical with the European *Ero furcata* (Villers) Although there are no major dif-

[6] Comstock, J H, *The Spider Book*, rev and ed, W J Gertsch, p 534 New York Doubleday, Doran & Co, 1940

ferences in the epigynum of the female and although the male palpus in both the American and the European specimens is nearly identical in most details, there are differences in the median apophysis Emerton's figure of the palpus brings this out plainly A comparison of specimens from Switzerland and North American males shows that in the former the median apophysis is prominent and single, whereas in American specimens it is blunt and bilobed The differences do not seem to warrant specific separation, but indicate that the American form is a separate geographical race Hentz's name is the first one available for it

Type locality — Male neoholotype and female allotype, Ramsey, Bergen County, New Jersey W J Gertsch, collector, June 3, 1934. American Museum of Natural History, New York

Distribution — Alabama Jackson County, Clear Creek, immature specimen, Lee County, Opelika, immature specimen, Madison County, Panther Knob, Monte Sano, female

Ecology — On dead leaves of the leaf carpet, slopes of hardwood ravines, on the under surface of a limestone slab in a rock pile at the end of a fissure on a mountain slope

Ero lodingi, sp. nov

Very close in appearance, size, and coloration to *E furcata leonina* and *E canionis* Carapace having a longitudinal dusky line,

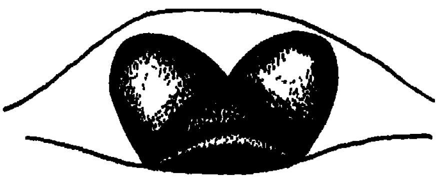

FIG 2 *Ero lodingi* Mobile, Mobile County, Alabama

not furcate, the line surmounted by a single anterior hair followed by two pairs of hairs Area around eyes not dusky, but lateral sides of the widely cordate carapace bordered with black Cervical pit deep Base of the abdomen a mass of black splotches on deep gray, and with white fat bodies interspersed and visible through the cuticula, border of pigmented mass wavy Apical half of abdomen light gray, with numerous white fat bodies visible, four horizontal lines

extending from the anus about halfway up the apical division, each line progressively wider. Legs having a series of blackish rings, femur, tibia, and tarsus three-banded, one band on the patella. Length 3.0 mm., length of first pair of legs 5.9 mm.

Epigynum as shown in Figure 2.

In external appearance this species differs markedly from all others in that the abdomen lacks tubercles.

Type locality. — Female holotype, Mobile, Mobile County, Alabama, January 16, 1941. Archer collection, Alabama Museum of Natural History.

The specimen was taken inside an overturned flower pot on the greenhouse property of H. P. Loding (urban area of Mobile).

Ero pensacolae Ivie and Barrows

Ero pensacolae Ivie and Barrows, Bull. Univ. Utah, 26, No. 6, 19–20, pl. 7, fig. 54. 1935.

Morphology. — The color of this species is noticeably lighter than that of other North American species. Gray and white tones predominate. *E. pensacolae* is the smallest species of *Ero* described from North America. The largest Alabama female measures 2.4 mm. in length, the other species attain at least 3 mm. The first pair of legs are of considerable length, being about 5.7 mm. The most distinctive characteristic, however, is the presence of two pairs of tubercles on the dorsum of the abdomen, the other species either have one pair or lack them entirely. The epigynum is shown in Figure 3.

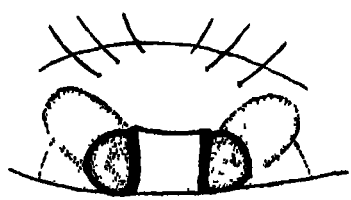

FIG. 3. *Ero pensacolae.* Cypress Creek, Lauderdale County, Alabama.

Type locality. — Gainesville, Alachua County, Florida.

Distribution. — Alabama: Lauderdale County, Cypress Creek, female; Baldwin County, Gulf State Park, slightly immature male. Florida: Santa Rosa County, Pensacola, female (W. M. Barrows).

Ecology. — On the upper surfaces of partly curled dead leaves, hardwood ravines (oak), and hammock woods.

ALABAMA MUSEUM OF NATURAL HISTORY
UNIVERSITY, ALABAMA

INDEPENDENT INHERITANCE OF CERTAIN CHARACTERS IN THE DEER MOUSE, *PEROMYSCUS MANICULATUS*

ELIZABETH BARTO

As PART of a study to obtain additional information on the segregation of hereditary characters in the deer mouse, *Peromyscus maniculatus*, tests for linkage have been completed between the following pairs of traits: albino and dilute, albino and postjuvenal nude, albino and waltzing (*bairdii* type), hairless and dilute, hairless and ivory, and dilute and ivory. Each of these characters has been shown by other investigators to be inherited as a single-factor autosomal recessive. The albino form was reported by Sumner and Collins (1922), hairless by Sumner (1924), dilute and waltzing by Dice (1933, 1935), nude by Clark (1939), and ivory by Huestis (1938).

The albino and hairless mice used were descendants of animals of these types which were sent to the University of Michigan by Dr. F. B. Sumner in 1925. Ivory mice were kindly supplied by Dr. R. R. Huestis. Dilute, waltzing, and nude mice were obtained from the stocks which have been maintained at the University of Michigan, where these characters were first observed.

Each of the linkage tests has been made in the repulsion phase. All of the F_1 generation had the wild-type appearance which is expected if the characters are produced by genes at different loci. Testcrosses (F_1's × double recessives) were made for each pair of characters studied. Data obtained from the F_2 generation also are presented for those experiments in which four classes of phenotypes were produced. The symbols used to designate the genes tested are the ones proposed by Clark (1938).

Chi-square tests have been used to determine the significance of differences between observed and expected results. A departure from expectation is considered highly significant if, with one degree

of freedom, the chi-square is more than 6 635 This value marks the one per cent level of probability and is equivalent to a standard error 2 576 times as large as the deviation

The formulas used to calculate chi-square are those listed by Mather (1938) Linkage relationships are shown by the joint segregation of the two pairs of genes being tested The segregation of the single factors, however, determines the formula most appropriate for obtaining the chi-square for detection of linkage The chi-square for single-factor segregations was determined, therefore, in each test by the formula

$$\chi^2 = \frac{(a_1 - la_2)^2}{ln},$$

where a_1 and a_2 are the observed numbers in the dominant and recessive classes, n is the total number of individuals, and l 1 is the expected ratio The same formula was employed for determining the chi-square for joint segregation in a testcross In this case a_1 and a_2 represent the observed numbers of parental types and recombinations The chi-square for detection of linkage in data from the F_2 generation was found from the formula

$$\chi^2 = \frac{(a_1 - 3a_2 - 3a_3 + 9a_4)^2}{9n},$$

where a_1 and a_4 are the numbers observed in the double-dominant and double-recessive classes, respectively, and a_2 and a_3, the observed frequencies in the two classes having one dominant and one recessive trait For those experiments in which a significant disturbance of one of the single-factor segregations was found, the data are also presented in contingency tables from which the chi-square for detection of linkage is determined from the formula

$$\chi^2 = \frac{(a_1a_4 - a_2a_3)^2 n}{(a_1 + a_2)(a_3 + a_4)(a_2 + a_4)(a_1 + a_3)}$$

This formula is unaffected by anticipated single-factor ratios and, therefore, is better adapted for revealing linkage when one of the single-factor ratios differs significantly from the expectation

I am indebted to Dr Lee R Dice for advice and criticism throughout the progress of the study and to Dr C W. Cotterman for suggestions concerning the statistical treatment of the data.

ALBINO AND DILUTE

Matings between albino (*cc DD*) and dilute (*CC dd*) mice had been made by Dr F H Clark, and dilute individuals extracted from this cross in the F_2 generation were kindly turned over to me Some of these mice proved to be heterozygous for albinism, and their use in producing the double recessives, which are phenotypically identical with *cc D* albinos, expedited this linkage test

Albino mice are always clearly distinguishable from colored ones The range of expression of the dilute character, however, extends from pale dilute, in which the hair tips are pale and the pigment in the basal half of the hairs is so much reduced as to appear white to the naked eye, to a condition indistinguishable from the wild-type even by microscopic examination Thus of 548 offspring from matings of *dd* × *dd* mice 12 (2 19 per cent) failed to show the character Unless the genes *c* and *d* are linked, therefore, a few more nondilute than dilute phenotypes would be expected in the testcross generation owing to inability to identify correctly all individuals homozygous for the dilute character

As described by Dice (1933), the principal effect of the dilute character "is greatly to reduce the amount of black on the tips of the hairs" Clark (1938) reported dilute mice to be characterized by a reduction of black pigment both "in the tips of the hairs and proximal to the agouti bands" He also found lumps of pigment in the proximal portion of the hairs Because some of the mice used in the testcross carried yellow genes, which also reduce the black pigment in the tips of the hairs, colored mice were classified as dilute or nondilute on the basis of the appearance of the proximal bands of their hairs The same criterion was used for classification of the offspring from the crosses of *dd* × *dd* mice mentioned in the preceding paragraph Microscopic examination for irregularities in pigment distribution in the bases of hairs plucked from the mid-dorsum was made for individuals which could not be readily identified by macroscopic inspection That the hairs might be long enough to show the character in *dd* genotypes, classification was made when the mice were twenty-four days of age or older

Offspring from the testcross were divided among three phenotypes as follows 66 colored nondilute, 61 dilute, and 110 albino mice (Table I) If the assumptions are made that animals in the three

TABLE I

ALBINO AND DILUTE

Testcross ($c\ D/C\ d \times c\ d/c\ d$)

Class	*Observed*	*Expected*
Colored nondilute	66	60 55
Colored dilute	61	57 95
Albino	110	118 50
Total	237	237

ANALYSIS OF CHI-SQUARE

Source of variation	*Degrees of freedom*	*Chi-square*
Colored albino ratio	1	1 219
Linkage (colored nondilute colored dilute ratio)	1	0 039

classes are equally viable, that no misclassification occurs, and that the genes are not linked, a 1 1 2 ratio would be expected In other experiments, however, 2 19 per cent of the *dd* genotypes were assigned to the nondilute class If it is assumed that the same amount of misclassification occurs in this experiment, the expected ratio is 70 nondilute 67 dilute 137 albino mice A 1 1 ratio between colored and albino mice is expected, and the observed results closely approximate this distribution Recombinations can be distinguished from parental types only in the two colored classes Consequently, these two classes alone furnish information concerning the linkage relations between the genes *c* and *d* If these genes are on different chromosomes, half of the 127 colored mice observed are expected to be *dd* genotypes, and half *Dd* With the correction for misclassification of 2 19 per cent of the *dd* colored mice the expected frequency of the two phenotypes is 64 89 nondilute and 62 11 dilute The chi-square for the nondilute . dilute ratio is then 0 039 for one degree of freedom The deviation is not significant and, moreover, no excess occurs in the parental-type class If the fiducial limit is set at 99 per cent the data would not fit a hypothesis of linkage with less than 39 per cent crossing over The assumption can be made, therefore, that the genes *c* and *d* either are on different chromosomes or are only loosely linked

ALBINO AND POSTJUVENAL NUDE

Postjuvenal nude (*nn*) mice can be distinguished from wild-type animals for a variable length of time Clark (1939) reported that loss of hair in nude individuals began between the ages of two and three weeks and became complete when the mice were between twenty-five and thirty-five days old He noted replacement of hair beginning when the mice were about fifty days old Some adults with this character had a bare nose and tail, others were completely normal in appearance In the present experiments, although some nude mice followed closely the schedule observed by Clark, others showed their abnormality for a shorter period For example, two females were indistinguishable from normal mice at the age of thirty days, although seven days earlier they had been observed to be nude

To obtain a better indication of the variability of the expression of this character, litters of seven matings between nude mice which had been observed to have conspicuous bare patches were examined at intervals of three days or less from the day of their birth until they were forty-four days old, and at intervals of four days or less between the ages of forty-five and fifty-one days Examination of some of the litters was continued for a longer period Since in each case both parents were nude, only *nn* genotypes were expected among the offspring Of a total of twenty-three offspring from these matings three appeared normal at each examination The deficiency of hair ranged in the others from slight thinning on the top of the head and on the posterior dorsum to total absence of hair except for the vibrissae The earliest age at which the character could be recognized ranged from fourteen to twenty-seven days

A bare spot was usually first noticeable in an area on the head between the ears and the eyes As a rule the posterior dorsum next became bare Hair was lost along the mid-dorsal line* before the sides became nude The order of progression varied, however In some mice the posterior dorsum became bare before any baldness was apparent on the head, in others loss of hair proceeded continuously caudad along the dorsum from the eyes to the tail. Except for its proximal quarter inch the tail sometimes did not become bare until after the new pelage had been acquired on the rest of the body In many specimens the region in front of the eyes, the sides of the

face, and the chin never became bare, even in mice which showed the character to a high degree

The earliest age at which hair of the next pelage appeared was thirty days and the latest was forty-seven days The interval between the time that loss of hair was apparent and the date on which incoming hairs were first seen ranged from eleven to twenty days The bare areas, colorless when they first appeared, were suffused with black pigment from one to eleven days before the tips of the hairs of the next pelage became visible Hair usually appeared first on the rump or saddle Sometimes the head was the first area on which hair was replaced, but more often it remained bald until the rest of the pelage was practically complete In all cases in which the base of the tail became bare it was the last part to regain its normal appearance Of the twenty mice in this group which expressed the postjuvenal nude character one appeared normal at thirty-eight days of age Four mice were characterized by a bare tail base at fifty-one days of age, when they were last examined Three in which the pelage had been completely regained at the ages of thirty-seven, thirty-eight, and forty-six days again acquired bare areas, so that at the age of fifty days they could once more be recognized as nude animals

In the F_2 and testcross generations from the cross of nude (*CC nn*) × albino (*cc NN*) mice all offspring classified as normal were examined at least once between the ages of twenty and thirty-seven days, with the following exceptions three of the F_2 generation were classified at the age of forty days and two testcross offspring at forty-two days of age Inasmuch as some *nn* genotypes do not differ in appearance from animals of the genotype *N*, a deficiency in the nude classes would be expected

The F_2 generation was made up of 184 wild-type mice, 67 albinos, 33 colored nudes, and 16 albino nudes The testcross offspring consisted of 108 wild-type, 102 albino, 51 nude, and 51 albino nude mice (Table II) This distribution differs noticeably from the 9 3 3 1 and 1 . 1 1 1 ratios expected if the characters are not linked and if all types are equally viable and can be reliably classified An analysis of chi-square shows that the discrepancy between observed and expected numbers is due principally to the deficiency in the nude classes The chi-square for the nonnude · nude ratio with one degree of freedom is 12 018 for the F_2 generation and 37 385 for the testcross

TABLE II

ALBINO AND POSTJUVENAL NUDE

Class	F_2 $(C\,n/c\,N \times C\,n/c\,N)$		Testcross $(C\,n/c\,N) \times (c\,n/c\,n)$	
	Observed	Expected	Observed	Expected
Wild-type	184	168 75	108	78
Albino	67	56 25	102	78
Nude	33	56 25	51	78
Albino nude	16	18 75	51	78
Total	300	300	312	312

ANALYSIS OF CHI-SQUARE

Source of variation	Degrees of freedom	Chi-square	
		F_2	Testcross
Colored albino ratio	1	1 138	0 115
Nonnude nude ratio	1	12 018	37 385
Linkage	1	0 290	0 115
Total	3	13 446	37 615

These deviations are probably due largely to inability to identify all the *nn* genotypes No significant departure from expectation is shown for the segregation of colored and albino types or for the joint segregation of the four traits The chi-square for joint segregation, calculated from the data as set up in contingency tables (Tables III–IV), is 0 719 for one degree of freedom for the F_2 generation and 0 056 for one degree of freedom for the testcross Neither value shows a significant departure from the results expected if the genes segregate independently Furthermore, the deviations are in the direction opposite to that which would be produced by linkage

ALBINO AND WALTZING

The waltzing character (*v-1 v-1*) tested for linkage with albinism arose in a stock of *P m bairdii* from Alexander, Iowa, and has been shown by Dice (1935) and Watson (1939) to be produced by a pair of genes at a different locus from that which controls waltzing be-

TABLE III

ALBINO AND NUDE

F_2 ($c\,N/C\,n$) × ($c\,N/C\,n$)

Chi-square for joint segregation = 0.719 for one degree of freedom

	Colored	Albino	Total
Nonnude	184	67	251
Nude	33	16	49
Total	217	83	300

TABLE IV

ALBINO AND NUDE

Testcross ($c\,N/C\,n$) × ($c\,n/c\,n$)

Chi-square for joint segregation = 0.056 for one degree of freedom

	Colored	Albino	Total
Nonnude	108	102	210
Nude	51	51	102
Total	159	153	312

havior exhibited in a stock of *P. m. artemisiae* from Lyon's Ferry, Washington. Dice reported variation in the degree of reaction of different mice and differences in the behavior of the same mouse on different days. Both he and Watson found that matings between waltzers produced a small proportion of offspring which did not express the character, and that deficiencies in the waltzing class were greater after outcrosses than when matings were made only between animals of the Alexander stock.

The study of the linkage relationship between albinism and the *bairdii* type of waltzing was initiated by Dr. Margaret Liebe Watson. She crossed waltzers with albino hairless mice and obtained a number of animals in the F_1 and F_2 generations. Additional matings after she left the University of Michigan increased the size of these generations. Hairless waltzers have not yet been obtained in sufficient

TABLE V

ALBINO AND WALTZING (*BAIRDII* TYPE)

Class	F_2 $(C\ v\text{-}1/c\ V\text{-}1) \times (C\ v\text{-}1/c\ V\text{-}1)$		Testcross $(C\ v\text{-}1/c\ V\text{-}1) \times (c\ v\text{-}1/c\ v\text{-}1)$	
	Observed	Expected	Observed	Expected
Colored nonwaltzers	89	77 625	56	51 75
Albino nonwaltzers	28	25 875	58	51 75
Colored waltzers	15	25 875	44	51 75
Albino waltzers	6	8 625	49	51 75
Total	138	138	207	207

ANALYSIS OF CHI-SQUARE

Source of variation	Degrees of freedom	Chi-square	
		F_2	Testcross
Colored albino ratio	1	0 010	0 237
Nonwaltzer waltzer ratio	1	7 043	2 130
Linkage	1	0 158	0 043
Total	3	7 211	2 410

numbers to test adequately the linkage relationships between these two characters, and therefore only the data which concern the inheritance of waltzing and albinism are presented here At the age of one month mice were tested for waltzing with the key-jingling apparatus described by Watson (1939) All mice classified as nonwaltzers were tested again at the ages of two and three months

Of a total of 138 F_2 individuals 89 were colored nonwaltzers, 28 were albinos, 15 were colored waltzers, and 6 were albino waltzers (Table V) Fewer than one fourth of the mice are included in the two classes of waltzers The chi-square for the segregation of nonwaltzing and waltzing types is 7 043, which indicates a significant deviation from the 3 1 ratio expected if waltzers and nonwaltzers are equally viable and if *v-1 v-1* genotypes always express the waltzing character Since, however, it is known that some *v-1 v-1* mice show only normal behavior with the testing apparatus used in this experi-

TABLE VI

ALBINO AND WALTZING (*BAIRDII* TYPE)

F_2 (c $V\text{-}1/C$ $v\text{-}1$) × (c $V\text{-}1/C$ $v\text{-}1$)

Chi-square for joint segregation = 0 206 for one degree of freedom

	Colored	Albino	Total
Nonwaltzers	89	28	117
Waltzers	15	6	21
Total	104	34	138

ment, the shortage of waltzers is not surprising Because of the significant deficiency of waltzers the chi-square for linkage was determined from a contingency table (Table VI) That the difference between observed and expected numbers is not due to linkage is indicated by the low value (0 206 for one degree of freedom) of this chi-square

As one means of obtaining albino waltzers gray waltzers of the F_2 generation were mated together or to F_1 individuals If waltzing and albinism are inherited independently two thirds of the F_2 colored waltzers would be expected to be heterozygous for albinism If the two characters are closely linked the proportion carrying the gene for albinism would be expected to be smaller Of five gray waltzers tested four had some albino offspring The evidence from these matings, therefore, also indicates that the two characters are inherited independently

From the testcross were produced 56 gray nonwaltzers, 58 albino nonwaltzers, 44 gray waltzers, and 49 albino waltzers (Table V) The analysis of chi-square shows no significant departure from expected numbers in this generation For the ratio between parental types and recombinations the chi-square for one degree of freedom is only 0 0435, a value which indicates very close correspondence between the observed results and the 1 1 ratio expected if the genes *c* and *v-1* are not linked

King and Castle (1937) found that in the rat (*Rattus norvegicus*) the genes for waltzing are linked to those for albinism with a crossover value of 45.8 ± 0 7 per cent No indication of linkage be-

tween albinism and the *bairdii* type of waltzing was found in the deer mouse In both the F_2 and the testcross generations the deviations from expectation were in the direction opposite to that which would be produced by linkage Nevertheless not enough animals were reared in these tests to disprove a hypothesis of linkage with as much as forty-five per cent crossing over If only deviations 2 576 times the standard error are considered highly significant, the data from the testcross would show highly significant departures from expectation only for crossover values of less than 41 77 or more than 59 68 per cent ($\rho \pm 2\ 576\ S_\rho$, where ρ is the observed proportion of the recombination types and S_ρ is the standard error of this proportion) If the genes for these two characters are not linked in the deer mouse it is probable that either the genes for albinism or those for the types of waltzing tested, or both, are not homologous in the two species Clark (1936) has shown that in the deer mouse the gene for albinism is linked to the gene for pink-eye, which produces a phenotypic effect similar to the character of the same name in the rat and the house mouse, and that the crossover value is approximately the same in the deer mouse as in the other two species Hence there is evidence that the genes for albinism in the deer mouse and in the rat are homologous In view of the facts that at least two types of waltzing are known in the deer mouse and that these are known to be produced by different hereditary factors, it would not be surprising if the gene for the *bairdii* type of waltzing is not homologous with the one for the waltzing character studied in the rat

HAIRLESS AND DILUTE

The age of hairless (*hr hr*) mice when their character first becomes noticeable varies considerably Sumner (1924) observed that loss of hair began at the age of two to three weeeks Of the hairless mice obtained in the F_2 and testcross generations following a hairless (*hr hr DD*) × dilute (*Hr Hr dd*) cross one had lost all its hair except the vibrissae by the age of nineteen days, others which appeared normal at twenty-seven days of age later lost their hair Mice from these crosses were never assigned to the nonhairless classes until they were at least twenty days old In most cases they were examined for hairlessness when they were thirty or more days old Unless the pelage appeared light dilute by macroscopic examination hair samples were inspected with the microscope for the presence of

TABLE VII

HAIRLESS AND DILUTE

Class	F_2 (*Hr d/hr D*) × (*Hr d/hr D*)		Testcross (*Hr d/hr D*) × (*hr d/hr d*)	
	Observed	Expected	Observed	Expected
Wild-type	225	207.5625	59	47
Dilute	59	69.1875	39	47
Hairless	75	69.1875	58	47
Dilute-hairless	10	23.0625	32	47
Total	369	369	188	188

ANALYSIS OF CHI-SQUARE

Source of variation	Degrees of freedom	Chi-square	
		F_2	Testcross
Nondilute: dilute ratio	1	7.813	11.255
Nonhairless: hairless ratio	1	0.760	0.340
Linkage	1	2.279	0.191
Total	3	10.852	11.786

diagnostic lumps of pigment. For hairless mice this examination was made when the loss of hair was first noted. Other individuals were examined for dilution when they were classified as nonhairless. Since in animals which develop the character only to a slight degree the irregularities in pigment distribution are confined to the most proximal parts of the hairs, it is possible that in some *hr hr dd* mice the early loss of hair may have prevented the expression of the dilute character.

The F_2 and testcross generations included, besides the four expected classes, some albino and albino hairless offspring. These were produced from matings in which the ancestry of each parent included some albinos from which an albino gene could have been inherited. It is therefore assumed that each of these parents was heterozygous for *c* as well as for *hr* and *d* genes. Since albinos could not be classified by inspection as dilute or nondilute, they are not included in the numerical list of the types observed. Inasmuch as

TABLE VIII

HAIRLESS AND DILUTE

F_2 (*Hr d/hr D*) × (*Hr d/hr D*)

Chi-square for joint segregation = 3 493 for one degree of freedom

	Nonhairless	Hairless	Total
Nondilute	225	75	300
Dilute	59	10	69
Total	284	85	369

TABLE IX

HAIRLESS AND DILUTE

Testcross (*Hr d/hr D*) × (*hr d/hr d*)

Chi-square for joint segregation = 0 359 for one degree of freedom

	Nonhairless	Hairless	Total
Nondilute	59	58	117
Dilute	39	32	71
Total	98	90	188

independent inheritance has been demonstrated between albinism and hairlessness (Sumner, 1924, 1932, Feldman, 1937, Clark, 1938) and between albinism and dilute, disregard of the albinos should not change the proportions in the four expected classes

Colored individuals in the F_2 generation were distributed as follows 225 wild-type, 59 dilute, 75 hairless, and 10 dilute-hairless The testcross included 59 wild-type, 39 dilute, 58 hairless, and 32 dilute-hairless mice (Table VII) Significant deviations from 3 1 and 1 1 ratios for nondilute and dilute mice are indicated in the F_2 and testcross generations by chi-squares of 7 813 and 11 255, respectively, for one degree of freedom This deficiency may be due to the failure of some *dd* mice to be distinguished from nondilute animals Because of the disturbance of the segregation between dilute and nondilute types chi-squares to detect linkage have been

calculated from contingency tables for the F_2 (Table VIII) and testcross (Table IX) data For the F_2 the chi-square is 3 493 for one degree of freedom, and for the testcross it is 0 359 Departures from the expected joint segregation are not significant The data can be explained, therefore, by assuming the characters dilute and hairless to be inherited independently

HAIRLESS AND IVORY

The F_2 generation from a hairless (*hr hr II*) × ivory (*Hr Hr ii*) cross included 252 normal, 67 hairless, 79 ivory, 20 hairless-ivory,

TABLE X

HAIRLESS AND IVORY

Class	F_2 (*Hr i/hr I*) × (*Hr i/hr I*)		Testcross (*Hr i/hr I*) × (*hr i/hr i*)	
	Observed	Expected	Observed	Expected
Wild-type	252	235 125	97	81 25
Hairless	67	78 375	72	81 25
Ivory	79	78 375	84	81 25
Hairless ivory	20	26 125	72	81 25
Total	418	418	325	325

ANALYSIS OF CHI-SQUARE

Source of variation	Degrees of freedom	Chi-square	
		F_2	Testcross
Nonhairless hairless ratio	1	3 907	4 212
Nonivory ivory ratio	1	0 386	0 520
Linkage	1	0 010	0 520
Total	3	4 303	5 252

and 1 albino (Table X) Both parents of the albino mouse had albinos among their ancestors, and its occurrence can therefore be explained by assuming the parents to be heterozygous for this character From the testcross were produced 97 normal, 72 hairless, 84 ivory, and 72 hairless-ivory mice Mice were classified when they were twenty-four days of age or older

The results obtained in the F_2 and testcross do not differ significantly from the 9 3 3 1 ratio expected if the characters are not linked Highly significant departures from expected proportions are not observed in either of the single-factor ratios or in the joint segregation of both pairs of genes The results therefore indicate that the characters either are not linked or, at least, are not closely linked.

DILUTE AND IVORY

The first matings designed to determine the linkage relations between ivory and dilute were made at the Cranbrook Institute of Science, which provided laboratory care of the animals and facilities for initiating this experiment Before the test had been completed the stocks were transferred to the University of Michigan, where the work was continued

Ivory (*D ii*) and dilute-ivory (*dd ii*) mice do not differ in appearance, and the expected proportions in the testcross if the genes are not linked are therefore 1 wild-type . 1 dilute 2 ivory

Because some of the dilute and ivory mice which were crossed were heterozygous for other mutant genes, many yellow and dilute-yellow, 4 albino, 3 pink-eye, and 4 cinnamon animals were produced in the testcross generation Yellow mice were readily separable into dilute and nondilute classes, and their presence caused no difficulty in classification The pale shade of the bases of the hairs of cinnamon and pink-eye mice makes the distinction between dilute and non-dilute types difficult It has been possible, however, by microscopic examination, to identify the dilute variation in some pink-eye and cinnamon mice, and data from matings which furnished these types are included in the tabulations The colored offspring from matings which produced some albinos are also included in the frequency distribution

One of the testcross matings has yielded twenty-eight offspring, all of which have normal-colored pelage Eight of these mice resembled postjuvenal nude animals in having large temporary bare areas after the juvenile pelage had been lost A similar absence of hair was noted in the F_2 generation in three mice from a mating which also produced forty-two offspring with the normal amount of hair The parents of the temporarily bald mice were all descendants of the same dilute × ivory mating None of them were related to any postjuvenal nude mice of the *osgoodi* type described by Clark (1939)

The deficiency of hair in these animals is being studied to determine whether the character is inherited, and it is hoped that information may be obtained which will explain the failure of either dilute or ivory mice to appear among the twenty-eight offspring from this one testcross mating Only one fourth of the mice in the testcross generation are expected to have pelage of wild-type color The probability that all the mice from this mating, by chance distribution of genes, would be of this type is therefore only $(\frac{1}{4})^{28}$ Since the wild-type color would be produced by a recombination of genes, any linkage between the *d* and the *i* genes would tend to reduce,

TABLE XI

DILUTE AND IVORY

Testcross $(D\,i/d\,I) \times (d\,i/d\,i)$

Class	*Observed*	*Expected*
Nondilute, nonivory	91	87
Dilute	89	87
Ivory	168	174
Total	348	348

ANALYSIS OF CHI-SQUARE

Source of variation	*Degrees of freedom*	*Chi-square*
Nonivory ivory ratio	1	0 414
Linkage (nondilute, nonivory dilute ratio)	1	0 011

rather than to increase, the proportion of mice in this group The distribution of offspring from this mating is therefore even less in accord with a hypothesis of linkage than with an assumption of random segregation of the genes *d* and *i* The results of this one mating are decidedly different from those of other testcross matings and, if added to them, would tend to conceal any indication of linkage if it does exist They are therefore not included in the tabulation of the testcross data.

From the testcross matings which produced some albinos 7 nondilute, 6 dilute, and 11 ivory mice were also obtained The litters of the testcross generation which included pink-eye and cinnamon animals consisted of 13 nondilute, 12 dilute, and 22 ivory specimens

The other matings of the testcross produced 71 nondilute, 71 dilute, and 135 ivory individuals The combined data (Table XI) from these three groups of matings show that 91 nondilute, 89 dilute, and 168 ivory mice resulted The observed results are very close to a 1 1 2 ratio Recombinations can be observed only in the nonivory mice The chi-square for the ratio between the nondilute, nonivory mice and the dilute mice is 0 414 for one degree of freedom and indicates a very close agreement with the 1 1 ratio expected without linkage

DISCUSSION

Cross (1938) counted forty-eight chromosomes in each of these species *P m gambelii*, *osgoodi*, *bairdii*, *artemisiae*, *sonoriensis*, and *blandus* The number in *P m hollisteri* he found to be fifty-two The mice used in the present study were hybrids between different subspecies, including *P m gambelii*, *osgoodi*, *bairdii*, and *blandus* *P m hollisteri* was not represented in any of the stocks employed It seems probable, therefore, that the mice on which linkage tests were made had twenty-four pairs of chromosomes, although no counts were taken for any of these individuals The purpose of the linkage studies has been to discover linkage groups and to determine markers for the different chromosomes

The only linkage group known in *Peromyscus* includes the characters albino and pink-eye and has been designated Number I by Castle (1940) These characters were shown by Sumner (1922, 1932) to be linked Clark (1936) demonstrated that the degree of linkage between them is approximately the same as that observed between albinism and pink-eye in the house mouse and Norway rat, which are included in linkage Group I of these two species His final determination (1938) of the amount of crossing over between the two genes in the deer mouse gave a value of 19 94 ± 1 44 per cent in females and 13 16 ± 2 70 per cent in males

Two other chromosomes in *Peromyscus* have been previously marked by yellow and hairless Sumner (1922), Feldman (1937), and Clark (1938) showed that albino and yellow are independently inherited Random segregation of albino and hairless was demonstrated by Sumner (1924, 1932), Feldman (1937), and Clark (1938), and yellow and hairless showed no linkage in the experiments of Feldman (1937) and Clark (1938)

The present study completes the evidence necessary to establish dilute as a marker for a fourth chromosome Clark (1938) found that dilute is not linked with yellow, and independent inheritance has been shown here between dilute and albino and between dilute and hairless

Four of the chromosomes, therefore, can now be designated by genes located upon them, as follows the albino chromosome, the yellow chromosome, the hairless chromosome, and the dilute chromosome

Independent inheritance of a number of other pairs of characters has been shown by other investigators (Feldman, 1937, Clark, 1938, Huestis, 1940) and by the present report, but no trait has yet been tested for linkage with markers for all four of the chromosomes listed above. Studies now in progress are designed to discover additional linkage groups or markers for the remaining twenty pairs of chromosomes

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MATING OF THE GARTER SNAKE *THAMNOPHIS SIRTALIS SIRTALIS* (LINNAEUS) *

FRANK N BLANCHARD † AND FRIEDA COBB BLANCHARD

A GENETICAL study begun in 1922 has branched out into a general life-history record of the garter snake *Thamnophis sirtalis sirtalis* In the earlier years of the work the genetical aspect predominated and other observations were incidental, the desired matings were obtained, but the process of mating was disregarded At that time only a few snakes were in use, and the male and female wintered together, so that only by chance was copulation seen in the spring But since 1932 the males have been segregated throughout the year, and only for the hour (more or less) required for courtship and copulation has a male been in the pit of a female At the earliest opportunity in spring the chosen male is, under this arrangement, dropped into the pit housing the female, perhaps with other females In order to know that the scheduled mating, and no other, occurs, it is of course necessary to watch the snakes carefully until the male is removed from the pit The routine, therefore, has not only given an excellent chance to observe mating behavior, but has necessitated observation of it

One not familiar with this behavior of the garter snakes may easily misinterpret it, erroneously assuming copulation when the snakes are merely in the position in which it might take place It seems obvious in a paper by D Dwight Davis [1] that this mistake has

* Contribution from the Department of Zoölogy, and Paper No 779 from the Botanical Gardens and Department of Botany, of the University of Michigan

† Most of the data on which this paper is based were gathered during the period when the authors worked together, from 1922 to 1937 (the year of Dr Blanchard's death), but a few additional records were made in the two subsequent springs For the manner of handling the data and the wording of the paper I am responsible F C B

[1] "Courtship and Mating Behavior in Snakes," *Zool. Ser. Field Mus Nat Hist.*, 20 (22) 257–290 1936

been made throughout the description of courtship and mating in *Thamnophis radix*, and that at no time during the observations did mating occur The fact that such a mistake can so easily be made and accepted prompted this report of mating as it has repeatedly been seen in the pits, where the snakes, though captive, are under the fairly natural conditions set forth in an earlier paper [2] No single instance is related in detail, but recorded data are summarized and a description given of typical behavior based on about fourscore instances Usually two observers working together have watched several pits at once, and in this way nearly a hundred copulations and many abortive courtships have been witnessed

THE TIME OF MATING

In very early spring, when the sunshine first brings out the snakes, their mating activity seems to depend on the weather alone A warm sunny day starts courtship, and, if conditions are good enough, copulation follows Though a record of temperature was not always kept we soon could recognize the right weather and learned not to waste time trying to work with the snakes unless the sun was shining and the air temperature above 60° F

In the pits the usual mating season is from early April to early May, the later half of April being the time when our work has been most profitable But matings have been secured in a warm spell in March, and as late as May 11 In the sixty-three matings of the years 1932–37 inclusive, the dates ranged from April 4 to May 4, except for four matings which were unusually early, on March 16 and 22, and three which were very late, on May 11 These extremes agree with those in nature, if we may judge from the meager field evidence at hand, but there are probably more of the early matings in nature than in the pits, for to conserve our time we let pass unused some questionably suitable days of which the wild snakes may have availed themselves

But later in the spring the weather of the day is not the only factor to be considered After a number of suitable days have passed the snakes, though still not mated, seem to lose the necessary impulse and become indifferent to each other For this reason

[2] Factors Determining Time of Birth in the Garter Snake *Thamnophis sirtalis sirtalis* (Linnaeus), *Pap Mich Acad. Sci , Arts, and Letters*, 26 (1940) 161–176 1941

many attempts to bring about copulation in May have failed, though the weather was perfect. The female is first to lack response, the male sometimes working for an hour or more before she is finally induced to copulate, and sometimes failing altogether. Early in May he, too, becomes languid in courtship until, at length, chancing to find a female, he shows no interest in her. Thus, in early spring (March and April) the weather of the day seems to be the determining factor in courtship and mating, whereas in late spring (very late April and May), when the weather is more uniformly suitable, it is the date (that is, the length of time since warm weather started) that apparently controls the activity. After the beginning of May one is lucky to secure mating.

In late summer there seems to be a reversal of this condition. Apparently there is no courtship in early summer, even on cool springlike days, but in August, when the broods are appearing, the males again pay some slight attention to the females, though their courtship is such as hardly to deserve the name. In Indian summer a bright warm day after early cool weather induces real courtship, which may even lead to copulation. Thus, after a certain date, suitable weather is all-important again.

The actual dates of copulations recorded in this paper have no significance other than that they were within the mating season, were suitably warm and sunny days, and were for us free of more urgent work.

COURTSHIP AND COPULATION

Transference of the male from his own pit to that of the female seems not to frighten him, and his abrupt arrival from above usually disturbs the female but little, if at all. The male at once begins a slow exploration of the unfamiliar pit, with much action of his tongue. Perhaps he recognizes the presence of a female and actually seeks her, but this seems doubtful, for, once he has accidentally stumbled upon her, his search when she eludes him is a very much more active hunt. When touched by the male the female may continue to lie quietly as before or may glide away a few feet, quickly, sometimes with vibrations of the tip of her tail.

As soon as the male happens to touch the female, if weather, temperature, and time of season are appropriate, there is no doubt of his interest. Exploration of the pit is abandoned. If she has not

darted away he noses (or, rather, "chins") his way rapidly along her back, usually but not always starting first toward the region of her vent, then turning and retracing his course forward again along her back until their tails lie close together, his body lying upon hers (or in part beside hers) with enough slack to keep the same general position. Usually the male is so much smaller that his head is far behind the female's. Often he chins too far forward and must gain the needed position by backing. Even if she is somewhat coiled his body seldom takes short cuts, but lies draped along hers, waved from side to side enough to maintain the superior posture. No part of his body encircles hers, though a part of it sometimes curves down to beneath hers and up again on the same side, and his vent region repeatedly loops well down near her vent. His tail is often twisted under hers, wedging it up from the ground for a few seconds, and, in a strenuous courtship, often a part of his body, beneath hers, throws it up from the ground repeatedly.

Though there may be several females in a group, and though the male may temporarily lose touch with the one he has started to court, he usually finds the original female again and persists with that one exclusively, ignoring the others. In a group of females he may become temporarily confused, his tail working actively about the tail of one female, his body rippling over the body of another in the group, but shortly he becomes oriented. If the female moves away he follows her, leaving the others, even gliding over them, without hesitation. This is so usual as to justify the statement that snakes have individuality to one another — unless perhaps the male recognizes his own scent on the female after having touched her, which seems less likely.

The male proceeds regardless of the similar activity of other males with the same female, apparently either oblivious to or possibly urged on by it, certainly not discouraged. When two or more males simultaneously court a female each is apparently as energetic or as languid as he would be were the others not present. There is certainly no evidence of deference by any male to priority or superiority of another. True, one male often seems to delay while another courts actively, but he will show no more zeal if isolated with an unattended female. This is his individual reaction. Because of the great difference in the vigor of different males, especially when the season for mating is not at its height or the weather conditions not

near the optimum, one must be cautious in suggesting that a male recognizes the dominance of his rival and so postpones courtship We have not seen any evidence of such forbearance

Possibly courtship by a male is intensified by the presence or similar activity of another male, though this, too, seems doubtful Certainly the presence of another male is not necessary for courtship at its highest intensity Several active males, each struggling for the position necessary for copulation, push one another from the female, but this seems to be done incidentally, not purposefully Apparently each male merely strives to attain and maintain the position, not to dislodge a rival

During the courtship the male is so intent as to be careless of disturbance, the female, however, retains her usual vigilance and is perhaps more than ordinarily alert

As soon as the male attains the mating position on the female, which is usually accomplished in a few seconds, his tail and posterior body feel continuously about hers in an exploratory manner, and convulsive waves within his body roll forward rhythmically It is hard to describe this motion, even while watching it, one can only say that a series of ripples or undulations within the body run forward from the tail, followed, after a pause of a few seconds, by another series of ripples It would seem that these might be a stimulation either to the female or to the male himself The contractions do not alter his position on the female From time to time, if copulation does not occur quickly, he begins all over again, turning and nosing down her body to the tail region, his chin in contact with her back, rapidly reversing and coming forward again to take up the old position, the manipulations with the tail, and the internal waves This repeats the maneuver following his first finding her, and would seem to be for reassurance It may be repeated many times in a slow courtship He may even wander off a little way and come back again to her, though this is unusual if the conditions are favorable

Several times attachment within two or three minutes has been seen, and once within a minute, but at least five or ten minutes of courtship has been more usual, and often, even with great energy on the male's part and perfect weather, the attachment has been accomplished only after half an hour or even an hour If the season and the weather are at their best, however, the preliminaries will be more brief.

Sometimes the male shows enough interest to take up the position along the female, but does little more, merely lying so in the sunshine Courtship unconsummated is common when either the temperature or the time of year is unsuitable In early spring, when the weather, though sunny, is still too cold, the male takes the position of courtship, with more or less of its activity depending on how nearly suitable the conditions are, as the conditions are relatively more favorable the male is more active But the preparatory maneuvers have often been seen to go on more or less vigorously for an hour or longer and then wane without copulation, the male finally wandering off Later, when the weather is perfect but the season too advanced and the females grown unresponsive, the males still continue courtship — for a time energetically, but gradually, as the days pass, with less and less vigor, until finally there is a period of mutual indifference This activity must not be interpreted as copulation, and the position of the male looping down at the female's vent must not be assumed to mean attachment In fact, that position indicates that attachment has *not* occurred

The act of copulation takes place suddenly and with a maneuver of the tails too quick to follow with the eye Apparently the raising of the female tail to a nearly vertical position is involved, but whether or not in part by the female herself is a question It seems as though the male in one of those upward wedgings of the female's tail with his suddenly throws it straight up There is a flash of motion of the pair, and then stillness The male usually relaxes and slides off the female just as soon as the hemipenis has been inserted, the vent being the only point of contact remaining As long as there is agitation, and the male holds his position over the female, it is safe to guess that there is no attachment, when attachment occurs no guessing is necessary, for it is made plainly visible by separation of the bodies except at that point, generally with enough tension to expose a rim of the soft internal tissues

After the paroxysm of attachment the female usually begins to glide very slowly away, dragging the male, who is carried along with only slight effort on his part The position of the male's body in relation to the female's shows which hemipenis is in use He may head in the same general direction as the female and contribute somewhat to the motion, or simply be pulled backwards They may settle down again or continue to move very slowly, but

during the time of attachment they do not move quickly if undisturbed Only rarely does the male repeat, and then in a sluggish manner, the glide up the back of the female The waves of contraction which rippled up the body of the male usually stop entirely at copulation, so apparently are not a part of insemination Though there may be some irregular movements, the quick energetic rhythm, characteristic of precopulation, very rarely occurs

The usual duration of the attachment has been found to be about fifteen to twenty minutes, but has varied from five to thirty minutes There is some evidence that insemination is not immediate, or at least not quickly completed, in that unusually short copulations have not given young At completion the hemipenis is reverted, not withdrawn, the pair quietly drop apart, and neither snake has any further interest in the other Though the male may promptly mate again, with another female, he shows no more interest in this one Only once, and that when a disturbance caused premature separation, has there been seen any further attempt by the male to resume mating with the same female after detachment But if the male finds another female he may at once repeat the whole act, and he may even complete a third successful copulation resulting in young The female, though, having once mated, seems intolerant of any further courtship, at least for some time

MISINTERPRETATION OF THE COURTSHIP POSITION

Frequently snakes seen in active courtship, or even lying quietly in the position taken in courtship, have confidently been reported as mating, or in copulation This mistake is perhaps natural But because of the vital difference between the two acts, and the fact that false genetical and physiological conclusions may result from confusing them, it has been thought worth while to emphasize here the differences in the two behaviors

The apparent discrepancies between this paper and that by Davis (*op cit*) are thought to result from such a misinterpretation, rather than from differences between the two species of garter snakes (*Thamnophis sirtalis* and *T. radix*), which are so alike that it would be rather surprising to find a great variance in their breeding behavior The few casual observations of *T radix* in our pits are in accordance, so far as they go, with those of *T sirtalis*, though the species has not been seen in copulation, it has been witnessed in a

courtship like that of *T sirtalis* and like that described in detail by Davis and interpreted as mating (shown in his Figure 33, erroneously described as a "copulating pair")

The described "copulation" of *Thamnophis radix* fits so exactly the often seen *courtship* of *T sirtalis*, but is so entirely at variance with the *mating* of *T sirtalis*, that only one conclusion seems possible the observer misunderstood the situation, and assumed and recorded copulation when the snakes took the mating position A brief discussion will make it clear that the account is entirely in accord with our findings for *T sirtalis* if it is accepted as a description of rather sluggish and unconsummated courtship, rather than of mating

In the first record of "copulation" of *Thamnophis radix* on April 19, "the day was bright and sunny with a chilly southwest wind and an air temperature between 50° and 60° F" It is known that snakes of the same species in different climates react differently to given weather conditions, but the locality of the observation of *T radix* is so similar to that where our studies are being made that one would expect similar reactions Here, copulation on a day of such temperature, especially with a chilly wind, would be unexpected, courtship, however, on such an April day, would be looked for These facts alone prompted a critical reading of the account, from which it was concluded that in no instance had mating occurred

On this bright cool day the male found the female and glided along her back "When the tails of the pair were together, the male stopped and began to bend the rear part of his body around hers Contact was apparently established almost immediately" But even under perfect weather conditions such quick contact has seldom been seen here, always it has been preceded by at least a brief period of the rhythmic muscular undulations of the male And almost invariably there is a lash of tails at the moment of attachment which would not have been overlooked Evidently the contact was assumed by the observer, because of the position of the male's tail

The account continues with a description of the convulsive waves of the male, "which were interpreted as indicating the actual orgasm" But in *Thamnophis sirtalis* these ripples, varying in frequency and in intensity with varying suitability of weather and season, are the most conspicuous movements of courtship and are practically absent during copulation When the hemipenis has been inserted the male almost invariably slips off the female at once,

the attachment at the vent being the only point of contact Evidently these snakes were not in copulation

If it is realized that in courtship the male's tail keeps moving, bending down about the female's vent now on one side now on the other, the further account is understandable "After a dozen or more contractions of his body, the male withdrew the hemipenis, turned his body, and seemed to make a new entry with the opposite hemipenis After about a dozen orgasms in the new position the pair separated voluntarily and the male moved away" That this was a rather half-hearted courtship, such as is not consummated, is shown by the comparative quietness of the male's tail and, further, by the fact that the male wandered away

When a second male, even more apathetic than the first, made an "attempt to copulate," the first returned quickly and "mated for the second time Ten minutes later the three snakes were lying quietly near one another [a definite indication that conditions were not right for mating] At a slight disturbance the first male left The second male immediately went through the courtship activities, running his chin along the back of the female from a point near the base of her tail until he had reached a position suitable for mating Copulation took place at once, following the same pattern as that described for the first male The hemipenes were employed successively as before The first male returned and tried to effect an entry from the opposite side, but was unsuccessful" From comparisons already made it must be plain that this female was not in copulation five times, as supposed, but was merely the object of languid courtship by two males

The female of the pair recorded as "in copulo" on May 10 "left quickly when they were disturbed The pair apparently broke readily, for the male was not dragged by the female, as has frequently been described" The implication is that this pair, too, were in the position of courtship, this, and the fact that the female could leave quickly, suggest that there really was no attachment If an attached pair is taken in the hands (as can be done in the pits without disturbing them when their heads are hidden in the leaf pile) a fairly strong pull can be given without separating them — a strain which even seems to threaten rupture of the soft tissues of the male At separation the hemipenis is not seen, which indicates that it is reverted (as would seem from its structure to be the only possible

manner of separation) rather than withdrawn Thus the female in copulation cannot dart away from the male, unless he simultaneously reverts the hemipenis

THE FEMALE'S PART

The part played by the female is not clear. Her usual reaction to the arrival of the male is only the watchfulness caused by any other slight disturbance Rarely, among the hundreds of times that a male has been dropped into a female's pit, has the female made a perceptible advance toward the male before she was found by him One female arched her tail in an unusual way, took on a most alert manner, and moved slowly in jerks toward the male, another moved slowly to the male and crawled back and forth over him, with the vent slightly open, and copulation occurred within a few seconds But such behavior is exceedingly rare, as a rule the female lies still until found by the male, unless she has been disturbed by his fall onto the leaves When he stumbles upon her she may continue to lie still and accept the courtship or she may take flight, sometimes violently lashing her tail or vibrating its tip. This vibration certainly is a recognition of the male, and perhaps a rebuff, for it has been noticeable in females refusing to mate Subsequent behavior seems to indicate that when a female flees, as is frequent, this is not an invitation for attention, but is an escape Young females, probably immature, have been seen to do this, and also females already mated, and it is quite common behavior when the season has advanced too far for copulation

During an accepted courtship the female seems quite passive But that the male is entirely responsible for that position of the female tail which is necessary for the entrance of the hemipenis, or, in other words, that he can force the mating, seems doubtful, for apparently a female may quietly resist copulation indefinitely The fact that a capable male may work actively for an hour or more and give up without securing an attachment indicates either that the female has some active part in the final maneuver or, more likely, that she may resist or allow it at will, rather than that she has no voluntary part in it At times a female which has lain perfectly still during persistent activity of the male for a long time will suddenly dart away, perhaps with a vibrating or lashing of her tail, as though the male had nearly accomplished copulation And the recorded instances of males found in copulation with dead females seem to

indicate that females have no active part in the maneuver of attachment, but resist or not, at will

Thus it appears that the female may have an active part in the act of copulation, stimulated to coöperation by the courtship actions of the male, but that more likely she has only the choice of resisting or not a manipulation which throws her into position for entrance of the hemipenis It would seem to be correct to say that a female accepts copulation, or refuses it

DURATION OF COPULATION

In only about half the matings has the duration of the attachment been recorded When several pairs which are being watched are in different pits it is very easy to miss seeing either the starting

TABLE I

DURATION OF COPULATION OF *THAMNOPHIS SIRTALIS SIRTALIS* AS SHOWN BY 58 MATINGS

Duration of copulation, in minutes	*Number of instances*			
	Total number		*Number followed by birth of young*	
5	1			
6				
7	2			
8				
9	2	13		
10	4		3	
11				
12	2		1	5
13	2		1	
14				
15	8		5	
16	7		5	
17	4		1	
18	4	33	2	18
19	1		1	
20	9		4	
21				
22				
23	1			
24	2		1	
25				
26				
27	2	7	1	3
28				
29				
30	2		1	

or the ending of the copulation, and often, too, the snakes are out of sight under the leaves when they separate

Duration of copulation, as shown by records of 53 matings, is usually from fifteen to twenty minutes (see Table I) About two thirds of the instances (33 of the 53) fall within these limits Of these 53 matings 26 were followed by fecundity and of these, likewise, about two thirds (18 of the 26) came within the limits of fifteen to twenty minutes

It may be noted that three successful copulations lasted only ten minutes, but that none of the five which lasted less than ten minutes produced young The minimum time for successful impregnation may, therefore, be assumed to be about ten minutes Possibly, however, insemination is immediate and quickly completed, and further attachment serves some other purpose If this is so, the five-minute copulations may be brief because they are noneffective, rather than noneffective because they are brief

TABLE II

A COMPARISON IN RESPECT TO DURATION OF COPULATION OF ALL MALES OF *THAMNOPHIS SIRTALIS SIRTALIS* WITH TWO OR MORE COMPLETE RECORDS IN THE YEARS 1932 39 INCLUSIVE

Other copulations of these males are not included because the duration was not recorded. Heavy type indicates that a brood was born in the summer following this copulation, light type, that the copulation failed to produce young, and (D), that the female died before time for giving birth, and no record was secured.

Male	*Approximate length of male, in mm*	*Duration of attachment, in minutes*
Small Brown	500	*7, **10**
TC	574–600	*5, **15**, 15 +, **16**, **16**
12–12	665 (about)	9 (D), 15 (D), 20
6,13,16–0	690 (?)–709	**15 +**, **18** (about)
2,8–10	625–655 (?)	**16**, **16**
3,9–0	638	**15**, * **17**
L Black	654–677	15, 17, 20
Brown	565–592	**10**, **15**, **15**, **15**, **16**, 17, 18, 30
0–2,6	675	**12**, 21 (D), **24** (about)
D	640–670	9 (an autumn mating), **20**, **20**, † **20 +**, **24**
U	735	**20**, 20
2–4,10	Rather small	**20**, 23 (D)
TB	690	20, **30 –**, **30 +**

* Second mating of this male on this afternoon

† Third mating of this male on this afternoon.

There is some indication in Table II that males vary in respect to duration of attachment, but the data are hardly sufficient to warrant more than a comment The last four males listed in the table certainly seem to have had a tendency to remain attached longer than the average time, especially TB, which was twice recorded as in copulation for about thirty minutes — once being interrupted at the end of that time It is noticeable that (excepting 2–4,10) these males with long duration are especially large, and that the smallest male, Small Brown, only 500 mm long, remained attached for a short time, though his ten-minute copulation produced a brood

USE OF THE TWO HEMIPENES

Only very recently has a record been kept of which hemipenis is used in a mating, and the data are scant It seems that the two are

TABLE III

A RECORD OF COPULATIONS OF MALES OF *THAMNOPHIS SIRTALIS SIRTALIS* WHICH MATED MORE THAN ONCE IN A SEASON, SHOWING WHICH HEMIPENIS WAS USED IN EACH INSTANCE

Male	Date	Hemipenis used	Duration of attachment in minutes
12-12	March 28, 1938	Right	20
	April 21	Left	15
	April 26	Left	9
W Black	March 24, 1939	?	10–15
	April 4	?	?
	April 4	Right	10
	April 22	Left	21 –
L Black	April 4, 1939	Right	16 +
	April 13	Right	17
0-2,6	April 20, 1939	Right	21
	April 24	Left	12
	April 25	Right	?
	April 27	Left	24 (about)
2-4,10	April 16, 1940	Left	20
	April 22	Left	23
2-4,6	April 27, 1940	Left	13
	May 9	Left	5 +

used with equal frequency, and that in successive matings they do not regularly alternate — at least if several days have elapsed between Unfortunately no record of this point was made on the occasions when a male mated twice or three times on the same afternoon Of the twenty-four records kept during the three years 1938–40, exactly one half show the right hemipenis in use, and one half the left The individual records of males which mated more than once in a season are given in Table III

RESULTS OF SUCCESSIVE MATINGS OF A MALE

Certain males, because of their genetical constitutions, were needed for several matings in one season, others were desirable because of their dependability for quickly successful courtship These considerations, with the need of doing as much as possible in a short time when the day was propitious, led to the use of the same male for a number of copulations in rapid succession As soon as a good male was free he was put into another pit In Table IV are recorded the occurrences of two (and, in one instance, three) copulations by the same male, one immediately following the other Those records in which the second female died before the time for the birth of the young have been discarded from this consideration

In general the second of the two matings seemed normal in every way, and the broods resulting were of normal size But two attachments were abnormally brief (five and seven minutes, the usual time being fifteen to twenty), and gave no progeny Perhaps the previous matings were responsible for the brevity and failure of these two In the instance in which three copulations were completed within eighty minutes three good broods resulted

The male's second approach was just as active as the first, and there is nothing to lead one to think that such successive matings are not natural

THE BIRTH OF THE YOUNG

As reported in an earlier paper (see footnote 2, page 216), the time of birth of young depends on the temperature of the months of May, June, and July, not on the time of mating — provided only that copulation occurs not later than the beginning of the warm weather that starts the preparation of the eggs for ovulation Matings delayed past this time result in broods born late The "period

TABLE IV

RECORDS OF TWO (AND, IN ONE INSTANCE, THREE) COPULATIONS BY A MALE OF *THAMNOPHIS SIRTALIS SIRTALIS* IN ONE AFTERNOON

Male	Date	Time	Number of minutes attached	Female	Date of birth of young	Number of young
TB	April 20, 1932	?	20	M	No record	No record
		Immediately after	?	R	Aug 5	23
D	April 19, 1932	?	20	C	Aug 31–Oct 15	13 (all dead)
		?	?	Q	Aug 4	25
D	April 9 1934	2 16–2 40	24	V	July 24	51
		?	(Brief attachment)	6–2	Aug 8	13 +
		3 05–3 25	20	W	July 25	35
Brown	April 9, 1934	?	16	B	July 26	24
		?	*	2,6–2	July 24	32
BA	April 26, 1935	1 42–1 57	15	AG	Aug 12	34
		2 37–2 54	17	2,6–2	Aug 25	26
Small Brown	May 1, 1936	1 40–1 50	10	7,8–0	Aug 17	38
		2 08–2 15	7	3,7–0	No brood	0
TC	May 4, 1936	?	?	2,10–2	No record	No record
		40 min later	5 –†	2,6–2	No brood	0

* Male was twice attached, but dislodged, while TC was attempting attachment

† Male tried to reattach, unsuccessfully Very late in the season (May 11), these two snakes mated again and were attached for fifteen minutes or more This is the only instance, during this work, of a female copulating twice

of development" (that is, the time between the beginning of preparation of the eggs and the birth of the young, regardless of when fertilization takes place) has varied from three months in a warm season to four months in a cool season

The number of young has varied from six (the first brood of a female three years old) to fifty-one Twenty-five to thirty-five is usual There is considerable difference among broods in the average length of the snakelings In most broods the males are, on the whole, slightly but significantly larger than the females at birth, but this advantage is lost by the end of the next season, and soon the females are conspicuously larger A study of the number and size at birth of the snakelings, the sex ratio within the broods, and the rate of growth from birth to maturity and old age has been made, and a report is in preparation

YOUNG RESULTING FROM MATING IN AUTUMN

On cool sunny autumn days courtship is often seen, and a number of apparently normal copulations have been recorded, in nature and in the snake pits These are probably effective, for several times a brood has been borne by a female without a spring mating It could not be said with certainty that such broods resulted from matings of the previous autumn and not from those of the preceding spring The evidence, however, is strongly against such carrying over of fertility to the second spring, for more than a dozen females known to have mated in the spring and to have had broods in the summer were entirely isolated through the following season and were barren

There is further evidence against the storing of sperm from spring to spring in the record of a black female with which we worked for several years One year she had a brood of striped snakelings by a striped male (melanism being a recessive character) The next season, by a black male, all her young were black The following season she again mated with a striped male, and had only striped young Apparently the sperm of the preceding season's mating did not function, else her broods would have been mixed in color, "contaminated" This indicates that though sperm may last from an autumn mating to a spring fertilization they apparently do not survive in the female from one spring to the next

Effective autumn mating is certainly not uncommon, but whether or not it is frequent has not been determined At different times at

least half a dozen females collected in the fall have had young next season without spring mating The odd ratios of striped and black young reported by E B S Logier [3] in broods from collected wild black females are difficult to explain unless the broods represented two males Melanism has been shown to be a simple Mendelian recessive,[4] so if broods from black females have both color patterns, striped and black snakelings should appear in equal numbers They are anything but this in wild collected females There seems to be a tendency for recently mated females to avoid another copulation immediately, and we have therefore suggested that the odd ratios, inexplicable on Mendelian lines alone, result from an autumn mating followed by another in the spring, rather than from two spring matings That sperm should be able to survive the winter is not hard to believe in view of the fact that in very early spring effective mating may occur on a warm day which is followed by cold weather, when the snakes retreat again to hibernation Broods from such abnormally early activity are not born earlier than those of matings of a month later, which suggests that the sperm hibernate with the female The question of autumn mating and survival of sperm has been discussed in an earlier paper [4]

FAILURE OF FEMALES TO HAVE YOUNG

Of fifty-four observed matings in the years 1932–37 inclusive forty gave young and fourteen (or about one fourth) were unproductive Unusually early matings, after which the females return to hibernation, are not less likely to be productive, for of the four recorded for March 16 and 22 three gave young, which is up to the general average Of the three very late matings, one produced a normal brood, one female had no young, and one died with no record obtained

The fourteen failures, which were scattered through the years, may be classed as follows

1 Three failures which may be attributed to interrupted copulations In one instance the snakes were frightened by observers

[3] "Melanism in the Garter Snake, *Thamnophis sirtalis sirtalis*, in Ontario," *Copeia*, 172 83–84 1929, "Some Additional Notes on Melanism in *Thamnophis sirtalis sirtalis* in Ontario," *Copeia*, 1 20 1930

[4] Blanchard, Frank N and Frieda Cobb, "The Inheritance of Melanism in the Garter Snake *Thamnophis sirtalis sirtalis* (Linnaeus), and Some Evidence of Effective Autumn Mating," *Pap Mich. Acad Sci , Arts, and Letters*, 26 (1940) 177–193 1941

(a class) and separated after five minutes Another pair separated after fifteen minutes, which is a normal time, but the male repeatedly tried to reattach, which is not normal behavior A third pair separated after seven minutes, for no evident reason This was the second mating of the male, and followed immediately on the first, which lasted ten minutes and was successful Since in other instances an immediate second mating by a male has produced young the seven-minute copulation was probably not complete

2 Three failures which may perhaps be attributed to old age of the female One of these females had been kept in our pits for fifteen years and could not well have been less than five years old when caught, making an age of at least twenty years She had borne young regularly for the six years previous to this failure, but the following autumn she was in poor condition and instead of hibernating normally she stayed out, and died The age of a second old female we do not know, but her very great size (1,104 mm) suggests great age She was caught on May 14, after the mating season, yet bore no young that year The following season she copulated with a male of good record, but had no young Perhaps she had reached sterility The third of these females was also exceedingly large (974 mm the previous autumn) She did bear a brood of thirty-three the year following this failure, it is true, but though we were able to keep her for three years after that, we were not able to accomplish even a mating

3 Three failures in which the mating records were not normal One pair was in copulation for fifteen minutes, but the male had worked hard for an hour previously, though the conditions were favorable, without response from the female Another of these three was the only instance we have observed of a female mating twice The two snakes were in copulation for five minutes on May 4 (forty minutes after the start of a previous copulation by the male) The male tried to reattach, and we assumed this to indicate incomplete insemination On May 11 (a very late date for mating) we introduced the male again and a fifteen-minute copulation resulted Even so, there was no brood A third female had had a brood without a spring mating The following spring an apparently normal mating occurred, but there were no young The next spring, however, she refused to mate and in the autumn had to be killed because of an unhealthy skin condition.

4 Three failures which could not be accounted for, but in which there was no brood history for the females One rather large female (mating with a very small male, possibly not mature and with no other mating record) was kept for four years, during which this was her only copulation, so there is no record of her fertility Another of these females had been born in 1923 and was at this time nine years old and 615 mm. long, but had never before mated The next year she mated again, but died soon afterwards, never having produced young Here again there is no record of fertility The last of these three females had been caught the year before, and this was the only season that she mated in the pits

5. Two *failures for which there is no evident excuse* The duration of copulation was recorded as normal in one instance (and not recorded as abnormal in the other), and the dates were normal, the male had a good fertility record, and had not just previously mated, each female had a good record, had borne young the year preceding, and bore the year following But here it is interesting to note that in two other instances a pair of snakes, which had been confined together constantly, failed to produce young one year, though they had the year preceding It is not known whether unfruitful copulations occurred or whether the snakes did not mate But these two failures, in addition to the two unaccountable failures under discussion, suggest that it may not be abnormal for a female to omit a year occasionally

It has been noticed at the Biological Station of the University of Michigan that many of the garter snakes caught in the vicinity well after the mating season is over and too early for the young to have been born from spring mating have no developing embryos or bear no young Of course it is not known whether or not these snakes mated

SUMMARY

1 Under the fairly natural conditions of the enclosures at Ann Arbor, Michigan, mating occurs on days of suitable weather from mid-March to early May, especially in late April After this period females which have not mated will not do so, and males soon cease courtship

2 In the autumn the garter snakes have another mating period Snakes caught in the late autumn, though prevented from mating the

next spring, may have young in the summer. But captive females, without autumn mating, have not borne young from the spring mating of the previous year This indicates that autumn mating may produce young, sperm presumably hibernating in the female

3 Courtship, more or less vigorous, often occurs when conditions are not suitable for copulation, it may last for hours, wane, and end unconsummated When conditions are right it may be as brief as two or three minutes, though that is not usual During a courtship which ends with copulation the female is usually quiet or moves slowly, while the male is very active, maintaining or repeatedly resuming his superior position, often quickly "chinning" his way toward her tail, suddenly reversing, and coming back to the original position with convulsive body ripples running forward from his tail

4 After attachment has been secured, the male slides from the back of the female and is generally quite passive, his rhythmic convulsive waves ceasing These waves are apparently connected with courtship, not with insemination

5 Attachment commonly lasts from fifteen to twenty minutes, but has varied from five to thirty Those lasting less than ten minutes have not produced young

6 Only one hemipenis is used in a mating The two are used with about equal frequency, but probably not alternately

7 The female's part in copulation appears to be passive, she accepts or resists it, but probably has no active part in it

8 After separation the male may immediately mate with another female, and even a third, producing young, but the female does not mate again — or at least not immediately

9 The broods of females which mate in late April are born from three to four months later, the date of birth depending on the summer temperature The number of young in a brood has varied from six (the first brood of a three-year-old female) to fifty-one The broods differ considerably in the average length of the snakelings Males are slightly longer at birth

10 About one fourth of the recorded matings gave no young. Some failures may be attributed to interrupted copulation, old age of the female, or some abnormal condition or circumstance, but for others there is no evident excuse In nature it has been observed that many adult females are barren.

University of Michigan

THE PALPIMANIDAE OF PANAMA

ARTHUR M CHICKERING

PETRUNKEVITCH (1911) listed only four genera and seven species of Palpimanidae in his *Index-Catalogue* Five of these species were from South America, two from the West Indies Three genera were represented by only the type species Banks (1929) found one female on Barro Colorado Island, Canal Zone, in June, 1924, and described it as a new species, *Otiothops macleayi* Dr Frank E Lutz, of the American Museum of Natural History, found a single female in June, 1915, on the island of Porto Rico, and Petrunkevitch (1929) described it as *O lutzi* Bryant (1940) recorded three females of *O walckenaeri* MacLeay and also the allotype male in her extensive collections from Cuba

Otiothops macleayi Banks appears to be the only palpimanid occurring in the regions of Panama where I have collected The species is common on Barro Colorado Island along the fringe of the cleared land in the vicinity of the laboratory buildings of the Canal Zone Biological Area, and I now have many specimens of both sexes from several localities in Panama, as recorded later in this paper

The most important features of the family may be summarized as follows only two spinnerets, the eight eyes heterogeneous and in two rows, either two or three tarsal claws, no epigynum; male palp simplified, maxillary lobes convergent; anterior tarsi and metatarsi provided with heavy prolateral scopulae, three pairs of cardiac ostia

A male has been selected as the allotype and described as follows

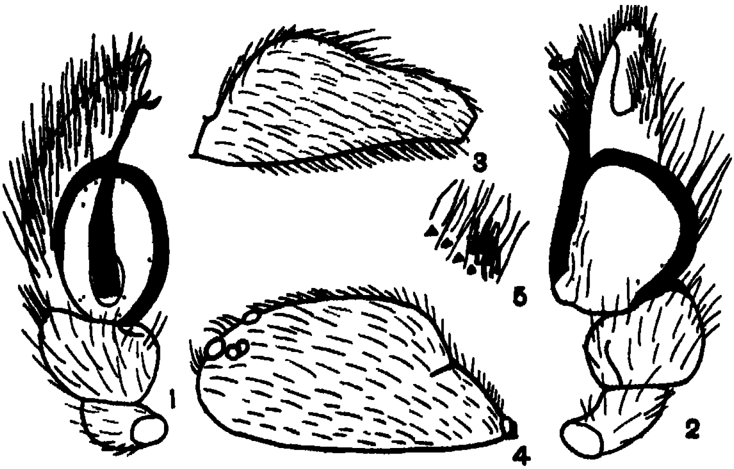
Otiothops macleayi Banks

(Figures 1–5)

Male allotype — Total length 6 7 mm Carapace 2 695 mm long, 1 96 mm wide opposite second coxae, almost perfectly oval as seen from dorsal view, posterior eyes occupying slightly less than nine elevenths of width of head, thoracic groove represented by a fairly

deep fovea at bottom of first abrupt declivity, very gently arched from posterior row of eyes to beginning of last fourth, then abruptly declivitous to fovea, and, after that, more gently sloping to posterior border (Fig 4), about two thirds as high as wide.

Eyes — Eight in two rows Posterior row only slightly longer than anterior row Observed from above, anterior row somewhat recurved, posterior row strongly procurved, so that lateral eyes



EXTERNAL ANATOMY OF *OTIOTHOPS MACLEAYI* BANKS

(Figures 1–5)

1 Male palpus, retrolateral view
2 Male palpus, ventral view
3 First femur, retrolateral view
4 Cephalothorax, lateral view
5 Fang groove with retrolateral teeth and cluster of spines

are practically contiguous AME round, LE oval, PME irregularly oval PME silvery, all others transparent Ratio of eyes AME ALE PME PLE = 7 5.5 4 5 AME separated from one another by six sevenths of their diameter, from ALE by five sevenths of their diameter PME separated from one another by two thirds of their diameter, from PLE by twenty ninths of their diameter Laterals separated only by a line Central ocular quadrangle wider in front than behind in ratio of 4 3, almost exactly

as long as wide in front Width of clypeus equal to eighteen sevenths of diameter of AME Ventral third of clypeus excavated and fringed with a thin whitish membrane (clypeal excavation much less evident in female holotype)

Chelicerae — Short, stout, with short fang, distinct ridgelike boss, roughened and irregularly corrugated on anterior surface Promargin of fang groove without teeth, retromargin with four small teeth (Fig 5) Peculiar cluster of nine stiff spines opposite tip of fang (teeth and spines determined from a paratype to avoid injury to the allotype, but confirmed on the latter) Females frequently with five teeth on retromargin as well as cluster of spines

Maxillae — Longer than wide in ratio of slightly more than 2 1, rounded along outer border, which is strongly chitinous distally Well-developed scopulae along mildly truncated distal medial corners A low tooth where maxillae meet a corresponding rough tubercle on sternum Moderately convergent

Lip — Generally triangular in shape, longer than wide in ratio of 19 17, distal end deeply notched About four fifths of length of maxilla Distal half gently excavated laterally and gently keeled centrally Sternal suture slightly procurved Rostrum projects beyond tip of lip

Sternum — Longer than wide in ratio of 30 21, widest between intervals separating first and second legs Convex, beaded, strongly chitinized parts extending dorsally between legs to membrane separating sternum from carapace, continued between fourth coxae, where it is truncate, fourth coxae separated by almost their greatest diameter Two small teeth near posterior truncature First coxae nearly twice as long as either second or third, and much stouter

Legs — 4123 Tibial index of first leg 14, of fourth leg 11

	Femora	*Patellae*	*Tibiae*	*Metatarsi*	*Tarsi*	*Totals*
		(All measurements in millimeters)				
1	1 84	1 60	1 22	0 55	0 66	5 87
2	1 43	0 88	1 16	0 95	0 55	4 97
3	1 59	0 70	0 98	0 87	0 50	4 64
4	1 67	0 98	1 51	1 47	0 61	6 24
Palp	0 65	0 18	0 28		0 70	1 81

Width of first patella at knee 0 405 mm , width of fourth patella at knee 0 27 mm First femora very stout, very convex dorsally on proximal halves (Fig 3), greatest dorsoventral diameter 0 96 mm ,

or slightly more than one half total length of segment Relative lengths of leg segments, as shown by table above, often very different from what is usual in spiders No spines First leg with true scopulae as follows complete iridescent prolateral tibial scopula, complete iridescent prolateral metatarsal scopula, small iridescent prolateral tarsal scopula on second quarter, small distal tarsal scopula of very short tenent hairs Second leg with a ventral metatarsal brush of hairs along distal half of segment, also with a short distal tarsal scopula Third and fourth legs same as second Elsewhere legs covered with a moderately heavy coating of fairly long hair Trichobothria apparently lacking Two curved claws throughout, seemingly alike, terminal tooth stout, longest, eight or nine others shorter, smaller, becoming retrocurved toward base Claw tufts small on posterior two pairs of legs, normal on anterior two pairs

Palp — Small, simple, with no apophyses Femur somewhat curved dorsally Cymbium long and slender, somewhat constricted at about two fifths of distance from base, with a retrolateral band of stiff black bristles Bulb ovoid, with embolus originating from outer side near basal end and extending in slightly sinuous fashion to near tip of cymbium, where it divides into two very slender processes, one straight, pointed, the other curved (Figs 1–2)

Abdomen — Regularly ovoid, only slightly flattened ventrally, quite thickly clothed with hair Epigenital area strongly chitinized and irregularly corrugated Chitinized epigenital area extends dorsally into a short but well-marked scutum No colulus visible Single pair of spinnerets short, tubular Anal tubercle short, blunt

Color in alcohol — Both carapace and sternum a rich reddish mahogany color, as are the first pair of legs, chelicerae, epigenital area, abdominal scutum, maxillae, and lip Remaining legs and palps a light amber Abdomen, except as otherwise noted, a duller reddish brown with yellowish dots

Type locality — Male allotype from Barro Colorado Island, Canal Zone, August, 1939 I now have in my collection ninety-four mature specimens of both sexes from the following localities: Barro Colorado Island, 1934, 1936, 1939, Porto Bello, 1936, Canal Zone Forest Reserve, 1939; Madden Dam region, 1936, 1939, Balboa, 1939

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AGE AND GROWTH OF THE YELLOW PERCH, *PERCA FLAVESCENS* (MITCHILL), IN THE WISCONSIN WATERS OF GREEN BAY AND NORTHERN LAKE MICHIGAN

RALPH HILE AND FRANK W JOBES

INTRODUCTION

ALTHOUGH the yellow perch occurs in the shallower waters throughout the Great Lakes and is of considerable importance to both commercial fishermen and anglers in many localities, the chief centers of commercial production are Lake Erie, Saginaw Bay in Lake Huron, and Green Bay in Lake Michigan Investigations of the age and growth of yellow perch in Great Lakes waters have been made of the Lake Erie perch by Jobes (MS) and of the Saginaw Bay perch by Hile and Jobes (1941) [1] The completion of the present study, the first on the growth of yellow perch in Lake Michigan, makes possible a comparison of the growth of the species in the three leading centers of production in the Great Lakes

The study of the growth of the Green Bay yellow perch is of particular significance because of the contention of Wisconsin fishermen that this stock of perch grows at an exceptionally slow rate The Green Bay fishermen believe also that the perch grows more slowly in the bay than in the open waters of Lake Michigan

MATERIALS AND METHODS

The determination of age and the calculation of individual growth histories from the examination and measurement of scales were carried out for 752 yellow perch collected in Green Bay (see Fig 1 for localities) An additional 90 fish, for which there were no sex

[1] Hile, Ralph, and Jobes, Frank W, "Age, Growth, and Production of the Yellow Perch, *Perca flavescens* (Mitchill), of Saginaw Bay," *Trans Am Fish Soc*, 70 102–122, figs 1–5 1941

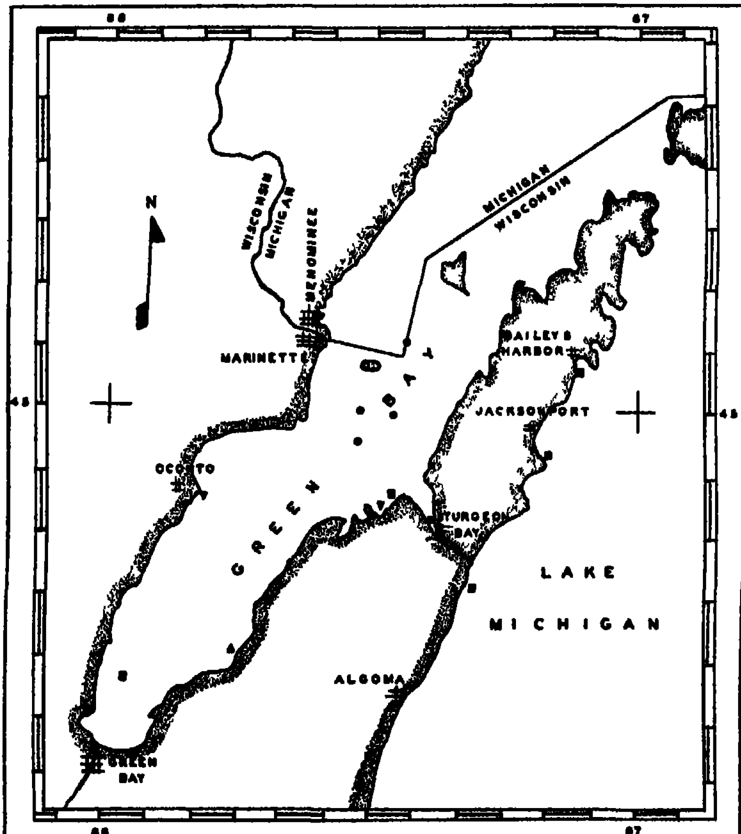

FIG 1. Localities at which samples of eighteen or more yellow perch were taken in Green Bay and Lake Michigan 1932, circles, 1934, upright triangles, 1937, squares, 1938, inverted triangles

data, were employed in the study of age composition (Table I), but their individual growth histories were not computed. All but the 1932 collections were taken in commercial gear The details concerning the collections follow·

1932 441 perch taken between April 27 and May 23, in experimental gill nets (mesh sizes 2⅜, 2½, 2⅝, and 2¾ inches, extension measure) fished from the Bureau of Fisheries vessel, *Fulmar*

1934 107 perch taken on March 24 in a 2–2½-inch-mesh pound net

1937 55 perch taken between November 26 and December 3 in a 2⅝-inch-mesh gill net and 3 (not included in Tables I and II, but included in body of Table IV) in a 2⅝-inch-mesh gill net, 74 fish taken on December 13 by a 2¼-inch-mesh fyke net (includes one fish without sex data, not used in the growth study) Eighty-nine fish for which sex data were lacking, taken on November 12 in a 2⅝-inch-mesh gill net, were employed for the study of age composition but not of growth

1938 73 perch taken between March 22 and April 5 in pound nets and fyke nets whose mesh sizes ranged from 1¾ to 2⅝ inches (more than half of the total from a 2-inch-mesh pound net)

In addition, ages were determined for five large fish selected for size

The study of the relationship between the length and the weight of Green Bay yellow perch was based on 938 fish, including all specimens employed in the investigation of age and growth and also those perch whose ages could not be determined and several scattered selected samples (large fish selected for size, samples of illegal fish only, samples of legal fish only)

The relationship between total length and standard length was determined from measurements of 509 yellow perch from Green Bay and 360 from the Beaver Island region of northeastern Lake Michigan. No significant differences were found between the data from the two areas

Collections of yellow perch totaling 276, taken in 2⅝-inch-mesh commercial gill nets between September 2 and October 13, 1937, were employed for the study of the age and growth of the perch in the Wisconsin waters of northern Lake Michigan (see Fig 1 for localities) Ages of four large selected fish collected in 1937 and 1938 were also determined The investigation of the length–weight relationship of perch in this area was based on 294 fish

Scales for age determination were mounted in a glycerin-gelatine medium and examined and measured on a microprojection apparatus at the magnification × 40 7 The calculation of growth was made by the method employed for the Saginaw Bay yellow perch (see note 1) In this procedure direct-proportion computations, based on the assumption that the body–scale ratio is constant, were employed for the determination of calculated lengths of 102 millimeters and greater Calculated lengths less than 102 millimeters were "corrected" to compensate for the disproportionate growth of body and scale among smaller fish It is realized that the correction of

the calculated lengths of the Green Bay and Lake Michigan yellow perch from a body-scale curve derived from Saginaw Bay materials may involve a certain degree of approximation It is not believed, however, that the error was large

Ages have been designated by roman numerals corresponding to the number of annuli on the scales, except for fish taken in the spring before the onset of growth For these fish an annulus was "assumed" to be present at the edge of the scale, and the age assigned exceeded by one the number of visible annuli

All materials and data obtained from Lake Michigan in 1937 and 1938 and from Green Bay in 1934, 1937, and 1938 were collected by investigators of the Wisconsin Conservation Department and made available to us through the courtesy of Dr Edward Schneberger, chief of the Biology Division The 1932 collections were made by Dr Hilary J Deason and other staff members aboard the Bureau of Fisheries vessel *Fulmar* We wish also to thank Dr John Van Oosten, in charge of Great Lakes Fishery Investigations of the U S Fish and Wildlife Service, for his numerous suggestions for the improvement of the original manuscript

AGE COMPOSITION AND LENGTH DISTRIBUTION

The age composition of the samples of Green Bay yellow perch (Table I) varied widely, with the dominant age group as young as II and as old as V The 1932 data suggest that mesh size of the gill nets employed had a significant effect on the age composition of the samples The samples from the 2⅜-inch-mesh net were dominated by age group IV, whereas the samples from the larger mesh sizes all were dominated by age group V The relative abundance of IV-group perch tended to decrease and the abundance of VI-group fish to increase with increase in the size of mesh

Dominant age groups in samples from commercial gears (the 2⅜-inch-mesh experimental gill net fished in 1932 may be considered commercial gear) were age group II in the gill-net sample of 1937, age group III in the fyke-net collection of the same year and the pound-net collection of 1934, and age group IV in the collections of 1932 and 1938 It should be mentioned, however, that the 1937 collections were made in late fall and early winter, whereas the collections of the remaining years were taken in the spring Consequently fish captured in 1937 had enjoyed one more season of growth

TABLE I

AGE COMPOSITION OF SAMPLES OF GREEN BAY YELLOW PERCH TAKEN IN DIFFERENT CALENDAR YEARS, IN DIFFERENT SEASONS, AND BY DIFFERENT FISHING GEAR (PERCENTAGES IN PARENTHESES)

Year and season	Kind of net, and mesh size in inches	Age group I	II	III	IV	V	VI	VII	VIII	IX	Total
1932 (spring)	2⅜ gill		2 (1.6)	2 (1.6)	68 (53.1)	41 (32.0)	14 (10.9)	1 (0.8)			128
	2½ gill			2 (1.9)	32 (31.1)	43 (41.8)	26 (25.2)				103
	2⅝ gill			1 (1.0)	27 (27.3)	50 (50.5)	21 (21.2)				99
	2¾ gill		1 (0.9)	1 (0.9)	21 (18.9)	53 (47.8)	31 (27.9)	4 (3.6)			111
1934 (spring)	2–2¼ pound		26 (24.3)	41 (38.3)	35 (32.7)	4 (3.8)		1 (0.9)			107
1937 (fall)	2⅝ gill		71 (49.3)	55 (38.2)	14 (9.7)	4 (2.8)					144
	2¼ fyke	2 (2.7)	21 (28.4)	44 (59.5)	7 (9.4)						74
1938 (spring)	1¾–2⅝ impounding			1 (1.4)	41 (56.2)	18 (24.6)	6 (8.2)	2 (2.7)	4 (5.5)	1 (1.4)	73
1932–38 (spring–fall)	All commercial gear *	2 (0.4)	120 (22.8)	143 (27.1)	165 (31.4)	67 (12.7)	20 (3.8)	4 (0.8)	4 (0.8)	1 (0.2)	526

* Excludes catches of 2½-, 2⅝-, and 2¾-inch-mesh gill nets in 1932

than had members of the same age groups in the collections of other years A better idea of the age composition of the commercial catch may possibly be obtained from a compilation made in terms of completed growing seasons (Table II)

Yellow perch that had completed four seasons of growth made up nearly half (46 2 per cent) of the combined samples of the commercial catch Next in abundance were perch that had completed three growing seasons (25 8 per cent) and five growing seasons (16 0 per cent) Other groups were represented only sparsely

TABLE II

AGE OF GREEN BAY YELLOW PERCH TAKEN IN COMMERCIAL GEAR, EXPRESSED IN TERMS OF THE NUMBER OF GROWING SEASONS COMPLETED

Number of completed growing seasons	*Number of fish*	*Percentage*
2	30	5 7
3	136	25 8
4	243	46 2
5	84	16 0
6	24	4 5
7	4	0 8
8	4	0 8
9	1	0 2

The age composition of the samples collected with 2⅝-inch-mesh gill nets in Lake Michigan in the fall of 1937 may be seen in Table III Age group IV was dominant (42 7 per cent), and the combined age groups III and IV made up 78 2 per cent of the total The only samples from Green Bay from 2⅝-inch-mesh gill nets (spring of 1932) were dominated by age group V. In terms of seasons of growth completed, however, these V-group fish correspond to the IV-group perch captured in Lake Michigan in the fall

It is not believed that the data on the age composition of the samples of yellow perch from either Green Bay or Lake Michigan are suitable for an analysis of the relative abundance of the year classes represented The chief defect of the data is the lack of adequate collections taken over a period of consecutive years by means of gear of the same type and mesh size A further weakness of the data for the Green Bay perch lies in the fact that most of the collections were taken during the spawning run In spawning-run samples the younger age groups that contain a high percentage of immature fish are not adequately represented.

TABLE III

AGE COMPOSITION OF THE SAMPLES OF YELLOW PERCH TAKEN IN THE FALL OF 1937 IN THE LAKE MICHIGAN WATERS OF DOOR COUNTY, WISCONSIN

Age group	*Number of fish*	*Percentage*
II	25	9 1
III	98	35 5
IV	118	42 7
V	27	9 8
VI	8	2 9

The length-frequency distributions of Green Bay yellow perch have been arranged in Table IV according to sex and the number of completed growing seasons (that is, with perch collected in the fall of 1937 combined with fish of the next higher age group of the spring collections of other years) As is commonly true of perch, the length distributions of fish of different ages exhibited considerable overlap, although this overlap doubtless was increased in the data for Green Bay perch by the combination of samples taken in different calendar years All length intervals at which fish were abundant were represented by perch of three or four different ages In fish of corresponding age the modal and average lengths of females consistently exceeded those of males

Females attained the State of Wisconsin's legal size of 7½ inches, total length (162 millimeters, standard length), earlier than males (Although a 7-inch limit was in effect at the time of the collection of the materials employed in this study, the limit was raised to 7½ inches on July 1, 1940, and is scheduled to be increased further to 8 inches, effective on July 1, 1943) At the end of two growing seasons all males and females were below legal length On the completion of three growing seasons, however, 96 0 per cent of the males though only 53 8 per cent of the females were undersized Relatively few of the females (9 0 per cent) but a majority of the males (57 6 per cent) were below the length of 7½ inches at the end of four growing seasons Undersized perch of both sexes were scarce at the end of five and six growing seasons (no undersized females at the end of six seasons), and all fish were longer than 7½ inches beyond the sixth year of life.

In the third and fourth columns from the right of Table IV may be seen the length-frequency distribution of all random samples of

TABLE IV

LENGTH-FREQUENCY DISTRIBUTION OF GREEN BAY YELLOW PERCH (COLLECTIONS OF ALL THE YEARS COMBINED) ACCORDING TO SEX AND THE NUMBER OF COMPLETED GROWING SEASONS

At right, the length distribution of all samples from commercial gear in Green Bay and the length distribution of all samples from commercial gill nets in Lake Michigan

Standard length in millimeters	Age in completed growing seasons														Length distribution of commercial catch			
	2		3		4		5		6		7		8	9	Green Bay		Lake Michigan	
	M *	F *	M	F	M	F	M	F	M	F	M	F	F	F	Number †	Percentage	Number ‡	Percentage
100–109	5	4													8	1.5		
110–119	6	11	1												16	3.0		
120–129	1	2	6	2											10	1.8		
130–139			7	8	5										19	3.5		
140–149			8	7	8	3									36	6.6		
150–159		1	2	8	18	13	1	1							79	14.6	3	1.0
160–169		1	1	12	10	34	8	3	1						98	18.1	13	4.5
170–179				6	9	44	4	10	1	1					83	15.3	71	24.5
180–189				5	4	50	4	18	4	6					82	15.1	84	29.0
190–199				2	3	37	7	43	5	7	1	1			51	9.4	50	17.3
200–209				2	1	33	10	42	5	18					27	5.0	44	15.2
210–219					1	22	7	40	2	20					7	1.3	10	3.5
220–229						6	1	16	4	14	1				6	1.1	9	3.1
230–239						1		4	1	7	1				3	0.5		
240–249						1		4	1	3			1		5	0.9	1	0.3
250–259								1				1			2	0.4	3	1.0
260–269								1		1		2			4	0.7		
270–279								1				1			1	0.2		
280–289													2		2	0.4	1	0.3
290–299										1				1	2	0.4	1	0.3
300–309													1		1	0.2		
Number of fish	12	19	25	52	59	244	42	184	24	78	3	5	4	1	542	100.0	290	100.0
Average length	111	118	137	161	162	186	190	204	204	213	216	258	279	294	172		190	
Percentage illegal §	100.0	100.0	96.0	53.8	57.6	9.0	7.1	1.1	4.2	0.0	0.0	0.0	0.0	0.0	30.8		1.4	

* M = male, F = female † Includes 16 fish whose ages were not determined
‡ Includes 14 fish whose ages were not determined § Less than 7¼ inches, total length (162 millimeters, standard length)

Green Bay yellow perch taken in commercial gear The percentage of undersized fish (7½-inch size limit) in the samples of the commercial catch was 30 8 The percentages of illegal-sized perch at size limits of 7, 8, and 8½ inches (an 8½-inch size limit is effective in the State of Michigan waters of the Great Lakes) were 21 5, 49 2, and 67 3, respectively

The additional information that would be obtained from the presentation of length–frequency distributions of the age groups of Lake Michigan yellow perch is not sufficiently great to warrant the expansion of the tabular material The length–frequency distribution of all Lake Michigan perch, however, is shown at the extreme right of Table IV Of the 290 perch (including 14 whose ages were not determined) in samples of the commercial catch (taken by 2⅝-inch-mesh gill nets) only 1 4 per cent were below 7½ inches in length At size limits of 7, 8, and 8½ inches the percentages of illegal-sized fish were 0 0, 9 0, and 34 8, respectively

GROWTH IN LENGTH AND WEIGHT

The average lengths and weights of the age groups of Green Bay yellow perch at capture and the calculated growth histories of the age groups are given for the males in Table V and for the females in Table VI The calculated lengths in these two tables exhibit numerous and at times large discrepancies Some of these disagreements are doubtless the result of the small numbers of specimens in certain age groups The remainder must be ascribed to other causes The discrepancies are in general similar in the data for both sexes

Lee's phenomenon of "apparent decrease in growth rate" with increase in the age of fish on which the calculations of growth are based occurred in the calculated lengths for the first three or four years of life The second-year and third-year calculated lengths exhibited these systematic discrepancies most sharply First-year lengths were affected less and fourth-year lengths only slightly. The calculated lengths in the later years of life gave no indication of the presence of Lee's phenomenon

A detailed discussion of the probable causes of Lee's phenomenon in the calculated lengths of yellow perch need not be given since the problem has been treated thoroughly by Jobes (MS) Although no study was made of the body–scale relationship in the Green Bay

TABLE V

AVERAGE LENGTH AND WEIGHT AT CAPTURE OF MALE YELLOW PERCH FROM GREEN BAY AND THE AVERAGE CALCULATED LENGTH ATTAINED BY THE AGE GROUPS AT THE END OF EACH YEAR OF LIFE

Age group	Year of capture	Number of fish	Weight in ounces	Total length in inches	Weight in grams	Standard length in millimeters	Calculated standard length in millimeters at end of year of life						
							1	2	3	4	5	6	7
VII	1932	3	6.2	10.0	176	216	57	91	130	151	175	200	216
VI	1932	20	5.9	9.6	167	209	57	93	121	151	180	209	
	1938	2	3.5	8.0	99	174	62	93	125	144	162	174	
V	1932	26	5.4	9.4	152	203	59	95	130	165	203		
	1934	2	3.5	8.2	98	178	57	95	130	164	178		
	1937	2	3.9	8.4	110	182	58	89	108	134	160	182*	
	1938	7	3.4	7.9	97	172	65	99	124	147	172		
IV	1932	7	4.3	8.7	121	189	58	96	140	189			
	1934	15	2.1	6.9	59	147	59	94	123	147			
	1937	7	3.3	7.7	94	166	62	95	122	148	166*		
	1938	11	2.9	7.6	81	165	64	104	138	165			
III	1934	21	1.5	6.3	43	134	66	104	134				
	1937	26	3.0	7.5	84	163	63	102	136	163*			
II	1934	12	0.8	5.2	22	111	67	111					
	1937	4	2.6	7.1	74	154	67	111	154*				
Grand average calculated length †							62	99	130	159	185	211	227
Annual increment of length							62	37	31	29	26	26	16
Number of fish							165	165	153	128	69	32	3

* Actual length at capture in November and December

† Beyond the fifth year of life the grand average calculated lengths were determined by the successive addition of the grand average annual increments of length to the grand average calculated length at the end of the fifth year

TABLE VI

AVERAGE LENGTH AND WEIGHT AT CAPTURE OF FEMALE YELLOW PERCH FROM GREEN BAY AND THE AVERAGE CALCULATED LENGTH ATTAINED BY THE AGE GROUPS AT THE END OF EACH YEAR OF LIFE

Age group	Year of capture	Number of fish	Weight in ounces	Total length in inches	Weight in grams	Standard length in millimeters	Calculated standard length in millimeters at end of year of life								
							1	2	3	4	5	6	7	8	9
IX	1938	1	24.0	13.5	680	294	55	79	121	165	189	212	236	260	294
VIII	1938	4	18.8	12.8	533	279	60	90	120	172	216	243	264	279	
VII	1932	2	11.7	11.7	333	254	55	85	126	164	192	225	254		
	1934	1	11.3	12.1	320	264	53	86	132	162	191	244	264		
	1938	2	14.2	11.9	402	259	56	88	118	154	200	236	259		
VI	1932	72	6.3	9.7	179	211	58	92	119	148	180	211			
	1938	4	14.0	11.8	398	257	58	90	130	182	225	257			
V	1932	161	5.6	9.4	159	204	59	94	129	166	204				
	1934	2	3.2	8.1	92	175	59	93	116	154	175				
	1937	1	3.6	8.0	102	173	50	78	112	134	154	173*			
	1938	11	9.5	10.3	268	224	64	103	151	194	224				
IV	1932	141	4.9	9.0	138	195	60	100	144	195					
	1934	20	2.7	7.5	76	162	62	99	134	162					
	1937	10	4.1	8.3	116	180	62	100	129	156	180*				
	1938	30	3.5	7.9	100	172	64	104	144	172					
III	1932	6	2.9	7.3	81	158	62	108	157						
	1934	20	2.1	6.9	59	148	69	107	148						
	1937	54	4.0	8.2	112	178	61	101	142	178*					
	1938	1	2.9	7.6	82	165	76	115	165						
II	1932	3	0.8	5.2	22	112	68	112							
	1934	14	0.8	5.3	23	114	67	114							
	1937	25	3.4	7.9	95	171	68	116	171*						
I†	1937	2	2.5	7.2	71	156	72	156*							
Grand average calculated length ‡							61	99	137	173	197	228	251	268	302
Annual increment of length							61	38	38	36	26	31	23	17	34
Number of fish							585	585	568	516	272	88	10	5	1

* Actual length at capture in November and December † Age group not employed in computation of averages
‡ Beyond the fifth year of life the grand average calculated lengths were determined by the successive addition of the grand average annual increments of length to the grand average calculated length at the end of the fifth year

perch, it appears safe to state nevertheless that the discrepancies represent in the main real differences in the growth of the fish in the various age groups and not methodical errors traceable to the procedure followed in calculating growth. It can be stated also that the selective action of the fishing gear and selective destruction of the more rapidly growing individuals in the commercial fishery were doubtless among the most important factors contributing to the observed differences in the growth histories of the several age groups. Segregation according to size and maturity also may have played a significant rôle.

Rather large discrepancies occurred also between the corresponding calculated lengths of yellow perch that were members of the same age group but were collected in different calendar years. Perch of the 1932 collection, especially age groups IV and V, were large at capture and had large calculated lengths in the later years of life. This rapid growth of perch of the 1932 collection is believed to be in large measure the result of the use in that year of gill nets of mesh sizes greater than the 2⅜-inch mesh commonly employed by commercial fishermen in the Wisconsin waters of Green Bay. Evidence in support of the belief that nets with larger mesh sizes tend to select the larger fish may be found in Table VII, in which are shown the average lengths of some of the best-represented age groups as determined from the samples of gill nets of different mesh size.[2] Particular attention should be given to the data for the females, since males were represented so poorly that their average lengths were included only to show that the data for both sexes exhibited similar trends. With one exception the average length of the females of each age group increased with increase in the size of mesh. The differences between the average lengths of the age groups of females as determined from the sample of the 2⅜-inch-mesh net (approximately the equivalent of commercial gill nets) and as determined from the combined samples of all nets were: age group IV, 7 millimeters, age group V, 13 millimeters, and age group VI, 20 millimeters. The differences between the average lengths of female perch captured by 2⅜- and 2¾-inch-mesh gill nets were: age group IV, 21 millimeters,

[2] Since it was believed that only those collections should be employed that had been taken in nets of different mesh size fished simultaneously, a collection from Sturgeon Bay, for the capture of which only the 2⅜-inch-mesh net was employed, was excluded in the preparation of Table VII.

TABLE VII

RELATIONSHIP BETWEEN THE MESH SIZE OF THE GILL NETS EMPLOYED IN TAKING THE SAMPLES AND THE AVERAGE STANDARD LENGTH IN MILLIMETERS OF THE REPRESENTATIVES OF CERTAIN AGE GROUPS IN THE 1932 COLLECTION OF YELLOW PERCH FROM GREEN BAY (NUMBER OF SPECIMENS IN PARENTHESES)

Mesh size (stretched measure in inches)	Length according to age group and sex					Average length of all perch taken in mesh *
	IV	V		VI		
	Female	Male	Female	Male	Female	
2⅜	188 (65)	201 (5)	191 (36)	197 (5)	191 (9)	190 (133)
2½	195 (31)	202 (7)	201 (36)	210 (7)	211 (19)	201 (106)
2⅝	206 (27)	220 (1)	211 (49)	207 (2)	211 (19)	207 (106)
2¾	209 (10)	202 (2)	215 (27)	227 (1)	218 (22)	210 (113)
Average	195 (133)	203 (15)	204 (148)	206 (15)	211 (69)	201 (458)

* Includes other age groups and 17 fish whose ages were not determined

age group V, 24 millimeters, and age group VI, 27 millimeters From these data it is apparent that the selective action of fishing gear may have a pronounced effect on the determination of the growth histories of samples of fish

Fluctuations in growth rate from one year to another also may have contributed to the discrepancies between the calculated growth of yellow perch of the same age group collected in different years

In spite of the rather large discrepancies in the calculated growth histories of Green Bay yellow perch of the same and different ages, it is believed that a general growth curve based on the combination of the collections from all years and localities and taken by various types of gear provides a reasonably reliable index of the rate of growth of the population The grand average calculated lengths and increments of length at the bottoms of Tables V and VI (see also Table XI for a direct comparison of the growth of the sexes and Figure 3 for a graphical representation of the growth of Green Bay perch) reveal that perch of both sexes made by far the greatest growth in length

in the first year of life The much smaller growth increments of the later years exhibited a distinct although at times an irregular downward trend (The males showed this trend more clearly than did the females) Beginning in the third year of life the calculated lengths of females exceeded those of males This sex difference ranged from 7 millimeters at the end of the third year to a maximum of 24 millimeters at the end of the seventh The legal length of 7½ inches, total length (162 millimeters, standard length), was attained by the females in the latter part of the fourth year of life and by the males early in the fifth year of life The ages at which lengths of 7, 8, and 8½ inches were reached were 7 inches, in the fourth year of life of both the males and the females, 8 inches, at the end of the fourth year of life of the females and about the middle of the fifth year of life of the males, 8½ inches, about the middle of the fifth year of life of the females and at the end of the fifth year of life of the males

The calculated weights of Green Bay yellow perch at the end of the different years of life (Table XII) correspond to the grand average calculated lengths, and were computed by means of the length–weight equation given on page 257 The calculated weights of males and females were the same at the end of the first and second years of life In later years the females had an advantage that varied from 7 grams at the end of the third year of life to 83 grams at the end of the seventh The averages for the sexes reveal that the Green Bay perch did not reach a weight of a quarter pound until the fifth year of life The weight of a half pound was reached in the seventh year of life, and the females weighed more than a pound in the ninth year

Since records of sex were not available for the collections of yellow perch from Lake Michigan, the discrepancies among the calculated lengths of the age groups (Table VIII) may depend in part on variations in the relative abundance of males and females at different ages. Other factors, mentioned previously, also doubtless contributed to the occurrence of Lee's phenomenon in the growth data for Lake Michigan perch In spite of the lack of sex records the data of Table XI indicate conclusively that Green Bay fishermen are in error in their contention that perch grow more slowly in Green Bay than in Lake Michigan The grand average calculated lengths of the Lake Michigan perch were well below the calculated lengths of female Green Bay perch in all years of life beyond the first and were

less than the calculated lengths of male Green Bay perch in every year of life but the sixth The slow growth of perch in the samples from Lake Michigan cannot well be attributed to the selective action of gear since they were taken by gill nets of relatively large mesh (2⅝ inches, stretched measure)

The calculated growth in weight of Lake Michigan yellow perch (Table XII) was computed by means of the length–weight equation given on page 257 By reason of their more robust form their calculated weights exceeded those of Green Bay perch in four of the six years of life for which comparisons were possible, and were equal to or only slightly less than the weights of Green Bay fish in the remaining two years of life

TABLE VIII

Average Length and Weight at Capture of Yellow Perch Collected in Northern Lake Michigan in September, 1937, and the Average Calculated Length Attained by the Age Groups at the End of Each Year of Life (No Records of Sex Obtained)

Age group	Number of fish	Weight in ounces	Total length in inches	Weight in grams	Standard length in millimeters	Calculated standard length in millimeters at end of year of life					
						1	2	3	4	5	6
VI	8	9 5	10 4	269	225	56	83	113	148	172	201
V	27	5 7	8 9	161	193	58	87	110	136	166	
IV	118	5 6	8 9	158	193	61	92	118	159		
III	98	5 1	8 6	144	187	61	99	145			
II	25	4 2	8 2	120	177	64	116				
Grand average calculated length *						61	96	128	154	183	212
Annual increment of length						61	35	32	26	29	29
Number of fish						276	276	251	153	35	8

* Beyond the fourth year of life the grand average calculated lengths were determined by the successive addition of the grand average annual increments of length to the grand average calculated length at the end of the fourth year

The data for a number of selected large yellow perch from Green Bay and Lake Michigan provide some idea of the maximum size and age attained in those areas The largest perch captured in Green Bay was a female with a total length of 14 3 inches (311 millimeters, standard length) and a weight of 26 ounces (737 grams).

This fish, which was taken one-half mile south of Marinette, was a member of age group VII There is no record of the gear in which the fish was captured The biological samples from Green Bay included a number of older fish but none so large The largest perch from Lake Michigan were three females taken off Bailey's Harbor in 4½-inch-mesh gill nets on March 29, 1938 At capture each weighed 28 ounces (794 grams) The ages, total lengths in inches, and standard lengths in millimeters were as follows age group VI, 13 8 inches, 300 millimeters, age group VII, 13 5 inches, 294 millimeters, age group IX, 14 3 inches, 311 millimeters

TABLE IX

RATIO OF STANDARD LENGTH TO TOTAL LENGTH OF YELLOW PERCH FROM GREEN BAY AND THE BEAVER ISLAND REGION OF LAKE MICHIGAN

Interval of standard length in millimeters	*Ratio of standard length to total length*	*Number of fish*
149 and less	0 844	57
150–209	0 853	657
210 and more	0 858	155

In the preceding discussion corresponding total and standard lengths have been presented without a statement of the relationship between the two Measurements of 869 yellow perch made possible the determination of the ratios of standard length to total length in fish of different sizes (Table IX)

LENGTH–WEIGHT RELATIONSHIP

Although the length–weight data of Green Bay yellow perch were tabulated originally according to sex and year of capture, the variation from year to year in the length distribution of the samples and the scarcity of males in some collections made a detailed analysis unfeasible Data presented here will be limited to the general length–weight curve based on a combination of all available materials It may be stated, however, that the Green Bay perch tended to be heaviest in relation to their length in 1937 and lightest in 1934 Females were heavier than males of corresponding length in 1932 and 1938, but were lighter in 1934 Sex differences were negligible in 1937 In the combined collections females averaged slightly heav-

ier than males (average coefficient of condition,[3] K, of 1 85 as compared with a coefficient of 1 81 for males over the length intervals in which both sexes were represented)

The lack of sex records for all but a few selected individuals of the Lake Michigan collections prevented the determination of possible sex differences in the length-weight relationship of yellow perch from that area

The comparison of weights and coefficients of condition of yellow perch from Green Bay and Lake Michigan by centimeter intervals of standard length (Table X) reveals that the Lake Michigan fish were much the heavier at the lengths represented by adequate numbers of individuals This advantage is reflected also in the higher grand average K (2 18 in Lake Michigan, 1 87 in Green Bay) To some extent their greater weights may be held to represent real differences between the populations, although seasonal and annual fluctuations in the length-weight relationship may also have played a rôle

The coefficients of condition of Green Bay yellow perch tended to increase with increase in length up to a length of 180 millimeters This increase was followed by a decline over the interval, 180–219 millimeters, and an increase beyond the latter length In the Lake Michigan perch the values of K tended to decline with increase in length among the smaller fish, but were extremely high at the greatest lengths

The fitting of parabolas to the length–weight data[4] yielded the following equations

$$\text{Green Bay, } W = 0\,9319 \times 10^{-5}\, L^{3\,133}$$
$$\text{Lake Michigan, } W = 5\,8405 \times 10^{-6}\, L^{2\,811}$$

In both equations W = weight in grams and L = length in millimeters

The solutions of these equations are represented graphically by the smooth curves of Figure 2 Comparisons with the empirical data reveal fairly good agreement within the intervals over which the equations were fitted The weights of the longer fish from both

[3] $K = \dfrac{W \times 10^5}{L^3}$, where W = weight in grams and L = length in millimeters

[4] The equations were fitted to the average lengths and weights by five-millimeter intervals of standard length

TABLE X

LENGTH–WEIGHT RELATIONSHIP OF YELLOW PERCH FROM GREEN BAY AND LAKE MICHIGAN

Interval of standard length in millimeters	Total length in inches equivalent to midpoint	Green Bay				Lake Michigan			
		Weight in grams	Weight in ounces	*K*	Number of fish	Weight in grams	Weight in ounces	*K*	Number of fish
100–109	4 9	19	0 7	1 62	10				
110–119	5 3	25	0 9	1 63	22				
120–129	5 8	34	1 2	1 74	39				
130–139	6 3	45	1 6	1 81	33				
140–149	6 7	58	2 0	1 88	44				
150–159	7 1	71	2 5	1 92	83	96	3 4	2 48	3
160–169	7 6	84	3 0	1 91	100	104	3 7	2 30	14
170–179	8 0	105	3 7	1 95	91	121	4 3	2 23	70
180–189	8 5	120	4 2	1 89	106	138	4 9	2 15	84
190–199	9 0	136	4 8	1 84	110	157	5 5	2 11	50
200–209	9 4	157	5 5	1 84	117	181	6 4	2 14	44
210–219	9 8	178	6 3	1 83	95	214	7 5	2 17	11
220–229	10 3	207	7 3	1 85	43	261	9 2	2 26	9
230–239	10 8	240	8 5	1 90	20				
240–249	11 2	288	10 2	2 04	10	295	10 4	2 01	1
250–259	11 7	370	13 1	2 34	2	391	13 8	2 28	3
260–269	12 1	406	14 3	2 18	4				
270–279	12 6	436	15 4	2 13	2				
280–289	13 1	624	22 0	2 67	2	473	16 7	2 02	1
290–299	13 5	652	23 0	2 57	2	709	25 0	2 79	2
300–309	14 0	598	21 1	2 14	2	794	28 0	2 94	1
310–319	14 4	737	26 0	2 45	1	794	28 0	2 64	1
Average or total				1 87	938			2 18	294

Green Bay and Lake Michigan were far greater than those computed from the length–weight equations

At the attainment of Wisconsin's legal length (7½ inches, total length, 162 millimeters, standard length) Green Bay yellow perch had a weight of 2 8 ounces (78 grams) and Lake Michigan perch a weight of 3 4 ounces (95 grams). The weights at 7, 8, and 8½ inches were 2 3, 3 4, and 4 1 ounces, respectively, in Green Bay and 2 8, 4 0, and 4 8 ounces in Lake Michigan. The advantages of the Lake Michigan perch at the three lengths were 0 5, 0.6, and 0 7 ounces.

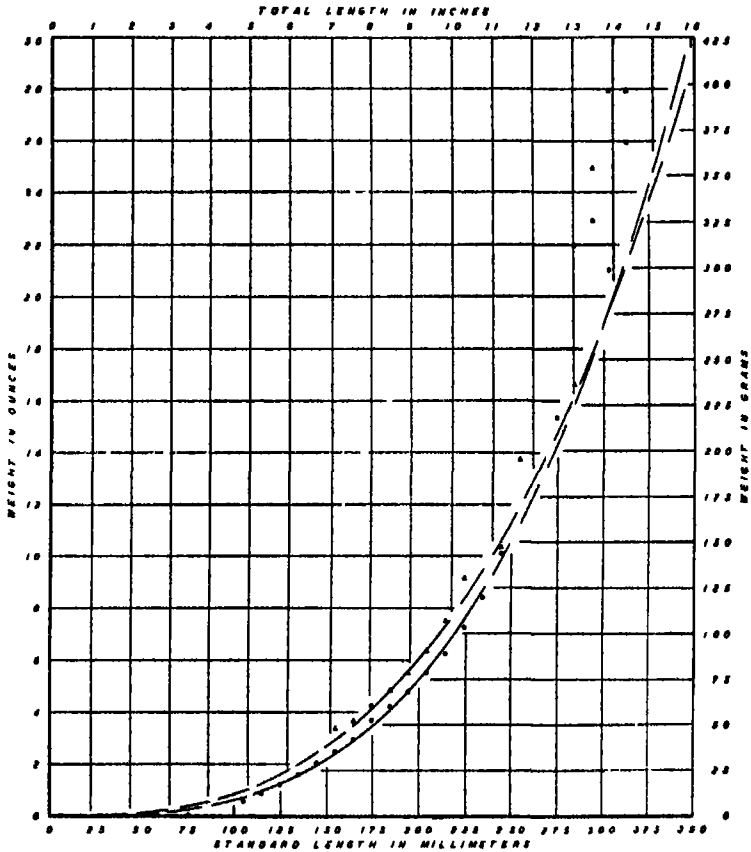

FIG 2 Length–weight relationship of yellow perch (sexes combined) from Green Bay (circles) and northern Lake Michigan (triangles) The solid-line portions of the curves represent the range of lengths to which the equations were fitted

SIZE AT MATURITY AND SEX RATIO

Records of the state of maturity were obtained for the Green Bay yellow perch of the 1932 and 1934 collections (The data on sexual maturity are based on 50 fish from bait nets of 1⅜-inch-mesh, 17 fish not aged in 1932, and 4 not aged in 1934, in addition to the

collections listed in Table I for 1932 and 1934) Practically all the males (128 in a total of 133) and 85 0 per cent of the females (413 in a total of 486) were mature Males were predominantly mature down to a total length of 5 inches A majority of the females were immature at all lengths below 7 inches More than half (58 8 per cent) were mature at 7 to 7½ inches, and nearly all were mature above the length of 7½ inches It cannot be concluded, however, that most female Green Bay perch become mature at 7½ inches, since the samples were taken during the spawning run in 1932 and shortly before the spawning run in 1934 Spawning-run samples tend to be made up almost entirely of mature fish Unpublished data on the Lake Erie perch have demonstrated that the percentage of mature individuals at the lower lengths was much higher in spawning-run samples than in samples taken at other seasons These Lake Erie data suggest that the length at which a majority of female Green Bay perch are mature is most probably greater than 7 to 7½ inches

The data on the relative abundance of the sexes in samples of Green Bay yellow perch were extremely variable The number of females per 100 males ranged from 114 in 1934 to 688 in 1932 and was 356 for the collections of all the years combined The change of the sex ratio with increase in age varied also Males tended to become more abundant with increase in age in 1932 (a spring collection) and 1937 (a fall collection) No distinct trend was apparent in the data for the 1934 and 1938 collections (both taken in the spring) The data on the sex ratio of the Green Bay perch lend further support to the growing belief that the sexes may be segregated throughout much of the year

COMPARISON OF THE GROWTH OF YELLOW PERCH IN GREEN BAY AND NORTHERN LAKE MICHIGAN WITH GROWTH IN LAKE ERIE AND SAGINAW BAY

Studies have been made of the age and growth of the Lake Erie yellow perch by Jobes (MS) and of the Saginaw Bay yellow perch by Hile and Jobes (see note 1) The data of Tables XI and XII and Figures 3 and 4 permit a comparison of the growth of perch in length and weight in four Great Lakes regions

The calculated lengths of Lake Erie yellow perch were considerably greater than those of yellow perch from other areas of the Great Lakes during the first three years of life The advantage of Lake

TABLE XI

COMPARISON OF GROWTH IN LENGTH OF YELLOW PERCH FROM FOUR AREAS OF THE GREAT LAKES

Locality	Sex	Calculated standard length in millimeters at end of year of life								
		1	2	3	4	5	6	7	8	9
Lake Erie	Male	76	143	181	203	220				
	Female	77	146	187	215	234	251			
	Both *	76	144	184	209	227				
Saginaw Bay	Male	65	114	166	204	232	259	275		
	Female	65	116	174	211	236	270	293		
	Both *	65	115	170	208	234	265	284		
Green Bay	Male	62	99	130	159	185	211	227		
	Female	61	99	137	173	197	228	251	268	302
	Both *	61	99	134	166	191	220	239		
Northwestern Lake Michigan	Both	61	96	128	154	183	212			

* Unweighted mean

Erie perch over fish from Saginaw Bay was reduced from a maximum of 29 millimeters in the second year to 14 millimeters in the third and 1 millimeter in the fourth At the end of the fifth year the Saginaw Bay perch were 7 millimeters longer than the Lake Erie fish Comparisons of the calculated lengths of perch from Lake Erie and Green Bay reveal that the advantage of the Lake Erie perch increased from 15 millimeters at the end of the first year to a maximum of 50 millimeters at the end of the third and then declined to 36 millimeters at the end of the fifth year The advantage of the Saginaw Bay perch over fish from Green Bay increased from 4 millimeters at the end of the first year to 45 millimeters at the end of the sixth and seventh years of life The Green Bay fishermen seem to be correct in their belief that perch grow relatively slowly in the bay, although their belief that they grow more slowly in Green Bay than in Lake Michigan is in error The calculated lengths of Lake Michigan perch were less than the lengths of Green Bay fish in all but the first year. The greatest difference (12 millimeters) occurred in the fourth year

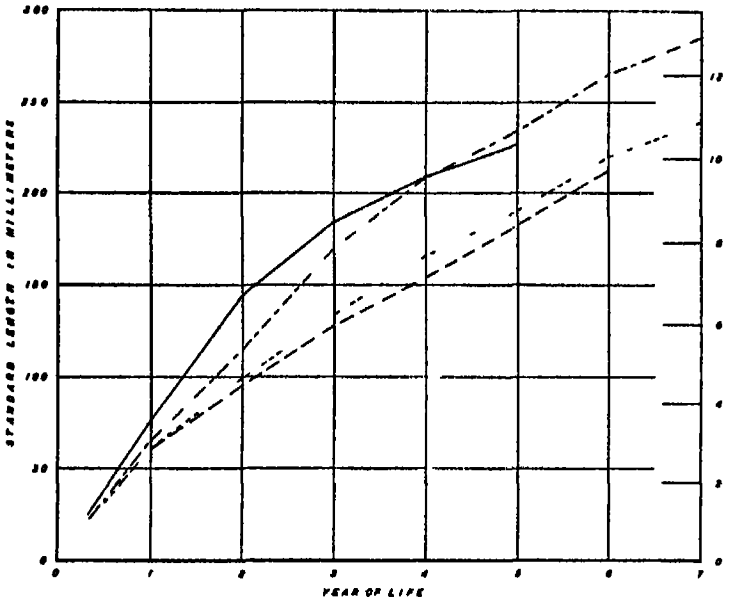

FIG 3 Calculated growth in length of yellow perch (sexes combined) Lake Erie, ——, Saginaw Bay, —·—·, Green Bay, -----, Lake Michigan, — — —

The legal length of 8½ inches, total length,[5] was attained by the Lake Erie yellow perch in approximately three years and by the Saginaw Bay fish during the fourth growing season. The Wisconsin size limit of 7½ inches, total length, was reached toward the latter part of the fourth growing season in Green Bay and in the early part of the fifth in Lake Michigan In these two localities approximately five years were required for the attainment of the length of 8½ inches, the size limit in Lake Erie and Saginaw Bay On the other hand, Lake Erie perch reached a length of 7½ inches, the size limit in the Wisconsin waters of Green Bay and Lake Michigan, at about the middle of the third growing season, and Saginaw Bay perch attained that length near the end of the third growing season

[5] Factors for conversions between standard and total length were slightly different in Lake Erie, Saginaw Bay, and Green Bay and Lake Michigan The total lengths shown in Figure 3 corresponding to the various standard lengths are the averages of the values determined separately for fish of each of the three areas

TABLE XII

COMPARISON OF THE GROWTH IN WEIGHT OF YELLOW PERCH FROM FOUR AREAS OF THE GREAT LAKES

The calculated weights correspond to the calculated lengths of Table XI

Locality	Sex	Calculated weight in grams at end of year of life								
		1	2	3	4	5	6	7	8	9
Lake Erie	Male	8	56	113	160	204				
	Female	9	59	125	190	246	303			
	Both *	8	57	119	175	225				
Saginaw Bay	Male	4	25	82	156	233	328	395		
	Female	4	27	95	173	245	373	482		
	Both *	4	26	89	165	239	351	439		
Green Bay	Male	4	17	39	73	118	178	224		
	Female	4	17	46	96	144	227	307	377	548
	Both *	4	17	43	85	131	203	266		
Northwestern Lake Michigan	Both	6	22	49	83	134	203			

* Unweighted mean

With respect to weight as well as length Lake Erie yellow perch were larger than yellow perch from Saginaw Bay during the first four years of life, but were smaller at the end of the fifth year The greatest difference (31 grams) occurred at the end of the second year The difference between the calculated weights of perch from Lake Erie and Green Bay increased progressively from 4 grams at the end of the first year of life to 94 grams at the end of the fifth year. Perch from Saginaw Bay and Green Bay had the same calculated weights at the end of the first year In later years, however, the Saginaw Bay fish had an advantage ranging from 9 grams at the end of the second year of life to 173 grams at the end of the seventh As mentioned previously (p 255), the advantage of Green Bay perch over Lake Michigan perch with respect to growth in length did not include growth in weight This difference with respect to growth in length and weight is to be explained by the fact that the yellow perch of the Lake Michigan population averaged somewhat heavier than the Green Bay fish of corresponding length

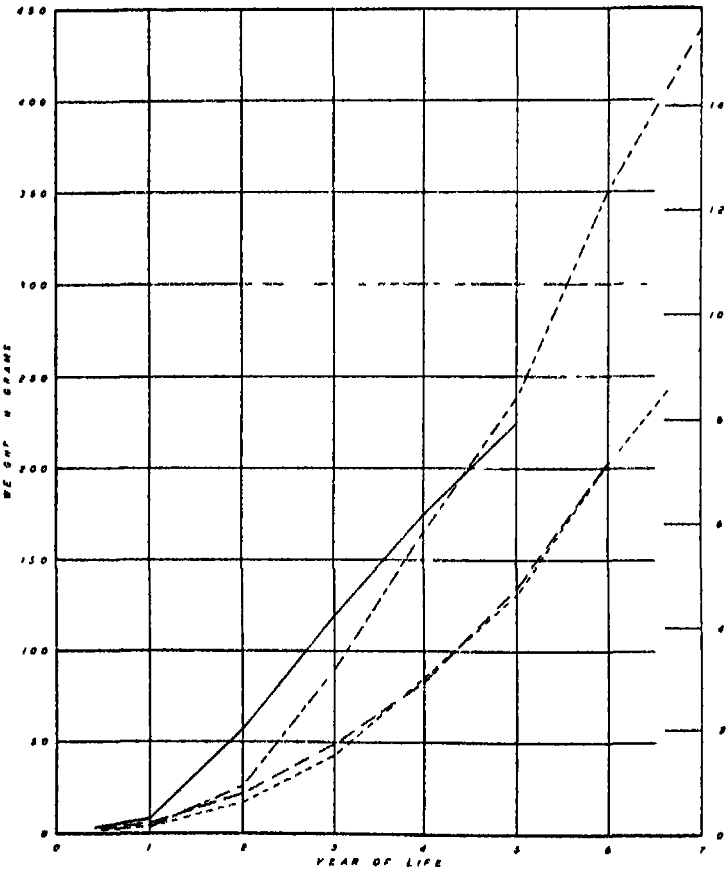

FIG 4 Calculated growth in weight of yellow perch (sexes combined) Lake Erie, ——, Saginaw Bay, —-—-, Green Bay, -----, Lake Michigan, — — —

SUMMARY

1 Ages of yellow perch were determined and individual growth histories were computed from the examination and measurement of the scales of 752 fish collected in 1932, 1934, 1937, and 1938 from the Wisconsin waters of Green Bay, and of 276 yellow perch taken from the Wisconsin waters of northern Lake Michigan in 1937. In

addition, ages were determined for 90 Green Bay perch for which sex records were lacking and for 9 large fish, selected for size, from both Green Bay and Lake Michigan Sex records were lacking for all Lake Michigan perch except the large, selected individuals

2 The numbers of fish employed for other phases of the investigation were length–weight relationship, 938 from Green Bay and 294 from Lake Michigan, relationship between total length and standard length, 869 collected in Green Bay and northeastern Lake Michigan

3 Samples of the commercial catch of Green Bay yellow perch were dominated by age groups II, III, and IV Samples taken by experimental gill nets with mesh sizes larger than those employed in the commercial fishery were dominated by age group V The collections from Lake Michigan were dominated by age group IV

4 The length–frequency distributions of the age groups of Green Bay yellow perch exhibited extensive overlap A majority of the females had reached the legal size of 7½ inches, total length, at the end of four growing seasons, but a majority of the males did not attain this length till during the fifth year In the combined samples from the catch of commercial gear 30 8 per cent of the perch were below the legal length of 7½ inches The samples from Lake Michigan contained only four (1 4 per cent) yellow perch less than 7½ inches long

5 The calculated growth histories of the age groups revealed some rather large discrepancies in the corresponding computed lengths of yellow perch of the same and different ages The probable factors contributing to these discrepancies were mentioned briefly

6 The general growth data showed that yellow perch of both sexes made by far the greatest growth in length during the first year of life The growth increments of the later years exhibited a distinct although an irregular tendency to decrease In the third and later years of life the grand average calculated lengths of females were larger than the corresponding lengths of males

7 Green Bay fishermen are in error in their belief that yellow perch grow more rapidly in Lake Michigan than in the bay The grand average calculated lengths of Lake Michigan perch (sexes combined) were less than the corresponding lengths of female perch from Green Bay in all but the first year of life and less than the corresponding lengths of male perch from Green Bay in all but the sixth year. Perch from Green Bay attained the legal length of 7½

inches late in the fourth growing season, those from Lake Michigan, in the fifth season

8 The calculated weights of Lake Michigan yellow perch tended to be slightly greater than those of Green Bay perch in corresponding years of life in spite of the slower growth in length of the Lake Michigan population

9 The relationship between the length (L) of Green Bay yellow perch in millimeters and the weight (W) in grams was $W = 0.9319 \times 10^{-5} L^{3.133}$ The length–weight equation for Lake Michigan yellow perch was $W = 5.8405 \times 10^{-5} L^{2.811}$ In both populations the weights of the larger perch (beyond the length intervals over which the equations were fitted) tended to be higher than the weights computed from the equations Lake Michigan perch almost always were heavier than Green Bay fish of corresponding length

10 In samples taken immediately before and during the spawning run a majority of the male Green Bay yellow perch were mature down to a length of 5 inches and a majority of the females were mature at 7 to 7½ inches Spawning-run samples, however, tend to contain only mature fish, collections taken at other seasons probably would first show a majority of mature females at a length somewhat greater than 7 to 7½ inches

11 The sex ratio of yellow perch in the collections of the different years from Green Bay ranged from 114 females per 100 males in 1934 to 688 females per 100 males in 1932 The relative abundance of males tended to increase with increase in age in 1932 and 1937. In 1934 and 1938 no consistent changes were noted in the sex ratio with increase in age

12 Comparisons of the calculated growth in length and weight of yellow perch from Lake Erie, Saginaw Bay, Green Bay, and northern Lake Michigan showed the Lake Erie perch to be the longest and heaviest during the first four years of life At the end of the fifth year Saginaw Bay perch were longer and heavier than the Lake Erie fish The growth of Green Bay perch was distinctly inferior to growth in Lake Erie and Saginaw Bay Lake Michigan perch grew somewhat more slowly than the Green Bay perch in length but not in weight.

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HYBRIDIZATION IN NATURE BETWEEN TWO GENERA OF FLOUNDERS IN JAPAN

CARL L. HUBBS AND KATSUZO KURONUMA

A CONSIDERABLE number of naturally produced interspecific fish hybrids, with characters almost uniformly intermediate between those of the parental species, have been described, and more are constantly being discovered (Hubbs, 1940: 205–209). The great majority of these hybrids are between fresh-water species, particularly of the families Cyprinidae (a large literature) and Centrarchidae (see particularly Hubbs and Hubbs, 1933, and Bailey and Lagler, 1938). Among marine fishes natural hybrids are much less frequent — perhaps because the ecological niches and the communities are more varied and less ephemeral.

The flatfishes (Heterosomata) of the families Bothidae and Pleuronectidae, however, resemble the fresh-water fishes in the frequency of hybridization between species which are so distinct as to warrant reference to separate genera. This is in line with ecological expectation. It is well known, as the result of many faunal surveys and a plethora of fisheries research, that in most northern regions several species of flounders often commingle in abundance over rather uniform habitats of sand and mud bottom, in shallow to moderate depths. The breeding seasons tend to be rather long, and are synchronous or overlapping for the different species. Reproductive habits are generalized; it is assumed that the pelagic eggs are fertilized as they start their ascent toward the surface. The wonder is that interspecific hybrids among the flounders are not more frequent.

Most of the known flatfish hybrids have naturally been described from European waters. The rather extensive literature, cited by Norman (1934: 266–267, 336, 354–355, 366, figs. 205, 258), refers to the following crosses:

Psetta maxima × *Scophthalmus rhombus*
Limanda limanda × *Platichthys flesus*
Platichthys flesus × *Pleuronectes platessa*
Limanda limanda × *Pleuronectes platessa*
Glyptocephalus cynoglossus × *Pleuronectes platessa*

Apparently Norman did not mention, and perhaps did not accept, Krause's (1881) description of one fish as a hybrid between *Platessa vulgaris* and *Rhombus maximus* (= *Pleuronectes platessa* × *Psetta maxima*) — in current taxonomy an interfamily as well as an intergeneric cross The rather well known hybrid between turbot and brill (*Psetta maxima* × *Scophthalmus rhombus*) was experimentally produced by McIntosh (1893 318–319, pl 4, see also McIntosh and Masterman, 1897 338-340, pl 13, fig 7) Kyle (1903 623–625) referred to the same studies, and recounted experiments on the production of embryos of the other relatively frequent and well-authenticated European flatfish hybrid, *Platichthys flesus* × *Pleuronectes platessa* That combination has recently been treated in commendable detail by Kändler (1935, 1936) and Pape (1936) In reporting a possible hybrid between diverse genera of soles (*Austroglossus* × *Synaptura*) Chabanaud (1937) has extended the literature on hybrid flatfishes systematically to the solaeiform Heterosomata, and geographically to Africa and the Southern Hemisphere There has been only one report (Nichols, 1918) of a hybrid flounder from the western Atlantic, but this specimen, on reexamination by Hubbs and Carrick (MS), has been interpreted as a teratological winter flounder (*Pseudopleuronectes americanus*) rather than as a hybrid between that species and *Limanda ferruginea*

To date only one interspecific hybrid combination has been indicated in the flatfish group for the Pacific Ocean Schultz and Smith (1936) and Herald (1941) have convincingly shown that the rare flounder of western North America called *Inopsetta ischyra* is an intergeneric hybrid *Platichthys stellatus* is obviously one parental species (as the senior author of the present paper has thought for years) Norman (1934 375–376, fig 271) and Schultz and DeLacy (1936 68) suggested that this flounder might be a hybrid between *Lepidopsetta bilineata* and *Platichthys stellatus*, but the analysis by Schultz and Smith points definitely to *Parophrys vetulus* as the other parent species

The published information on interspecific hybrids within the Pleuronectidae may be summarized as follows Four combinations are reported to occur in European waters (the *Psetta* × *Scophthalmus* cross is within the Bothidae) and one on the Pacific Coast of North America. (We regard all these hybrids as intergeneric) Some evidence for the hybrid interpretation has been furnished by the

experimental production of embryos of two combinations, but the best evidence is circumstantial. In view of the very extensive flounder fisheries which have yielded all the presumed hybrids one can feel confident that these forms are too rare and too sporadic in occurrence to represent self-perpetuating species A large number of circumstances, involving habitat selection, spawning seasons, and general behavior, favor their interpretation as interspecific crosses The genetic evidence is that the characters all tend to be intermediate between those of the assumed parent species, and often variably intermediate In all these respects they conform with the general rules regarding interspecific fish hybrids (Hubbs, 1940 205–209), including the combinations which have been clinchingly demonstrated by experiment

Another observation of interest in connection with the new flatfish hybrid combination described in this paper is that two of the four European pleuronectid hybrids involve *Platichthys* as one of the parental genera, and the one other accepted combination in the family is between *Platichthys stellatus* and another genus and species In other groups, too (as in Cyprinidae and Centrarchidae), certain forms are particularly wont to hybridize with other species

KAREIUS BICOLORATUS × *PLATICHTHYS STELLATUS*

During his field studies of 1929 in Japan the senior author discovered that *Platichthys stellatus* hybridizes with a related flounder, *Kareius bicoloratus* Since that time Hikita (1934 11–15, of English section, and pl 2), on the basis of two specimens collected by him at Oshoro, Hokkaido, has described this hybrid under the new generic and specific name, *Pseudoplatichthys oshorensis* Hikita's description and his plate, which beautifully portrays a male and a female adult in color, correspond in all essential respects with the specimens which we have studied Hikita's statement of the relationships of the nominal genus and species is as follows

> This new species is allied to *Kareius bicoloratus* and *Platichthys stellatus*, but differs from the former in the following characters, cranium, clavicle, interclavicle, first interhaemal spine and otolith larger in size, two lower pharyngeal bones separated (a deltoid bone in *K bicoloratus*), vertical fins with many black bars and body with stellated tubercles (horny plates in *K bicoloratus*), and from the latter, body dextral (sinistral in *P stellatus*), much more bony prominence on cranium, vertical fins with comparatively indistinct black bars and fewer stellate tubercles on body

The evidence for interpreting these fish as hybrids is again circumstantial, but quite convincing in our view All the pertinent information which we have been able to derive from our own field and museum studies and from published observations harmonizes with this interpretation

THE DISTRIBUTION, HABITAT, AND SPAWNING SEASON OF THE PARENTAL SPECIES

Platichthys stellatus and *Kareius bicoloratus* overlap widely in their geographical distribution (Fig 1), as was well demonstrated by the senior author in 1929, when he made frequent collections along both coasts of Japan The Pacific species of *Platichthys* ranges from the outer coast of Santa Barbara County in Southern California to the Bering Strait region of Alaska, and thence eastward to Coronation Gulf near the middle of the Arctic coast of Canada, also along the Aleutian Archipelago to the Commander Islands, and southward from the eastern coast of Kamchatka and the entire Okhotsk Sea to central Japan It is not clear from the statements of Andriashev (1939 48, 72, 181) whether the species ranges northward on the west side of Bering Sea to Cape Navarin and the southern part of the Gulf of Anadyr The southern limits in Asia appear to be as follows on the mainland, the vicinity of Gensan, in mid-eastern Korea (Chosen), on the west coast of Honshyû, the Noto Peninsula, and on the Pacific side of Japan, probably no farther than Kasumiga-ura (Okada and Ikeda, 1938 120, we suppose that the extension of the range to Tokyo, as given by Soldatov and Lindberg, 1930 410, and Norman, 1934 384, was based on Tokyo market specimens shipped from farther north) *Kareius bicoloratus* is confined to Asia, and inhabits the shore waters from the Kurile Islands (Chishima), southern Sakhalin (Karafuto), and Peter the Great Bay (Taranetz, 1938 121, 129, fig 5), southward to the Inland Sea along the Pacific coast, to northern Kyûshyû along the eastern side of the Sea of Japan, and on the mainland through the Yellow Sea to the southern shore of the Shantung Peninsula in China The overlap in distribution along the eastern coast of the Sea of Japan is thus about 10° of latitude, and is nearly as much on the two other coast lines of Japan

The several localities in Japan where the hybrids were secured (Fig 2) lie within the area in which the ranges of the two parental

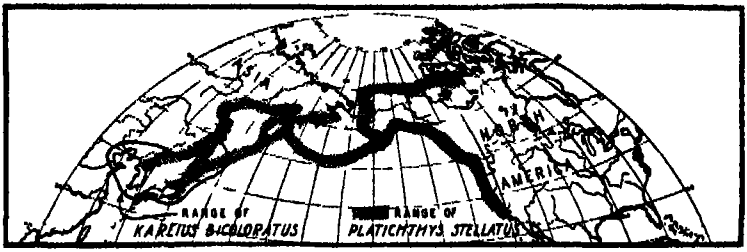

FIG 1 Map showing the overlapping distribution of *Kareius bicoloratus* and *Platichthys stellatus*

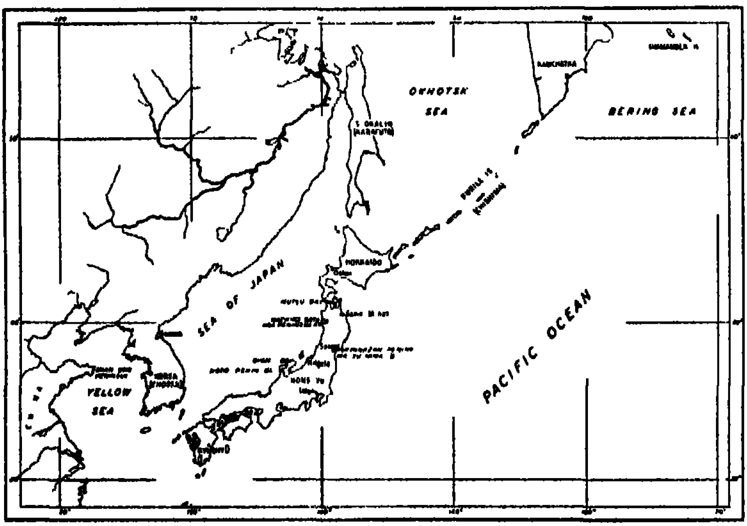

FIG 2 Asiatic localities mentioned in the chart, including those where the interspecific hybrids were secured

species overlap Following is a list of the record stations and of the hybrid material obtained.

Oshoro, Hokkaido· two adult hybrids (reported by Hikita, 1934) *Platichthys* and *Kareius* occur in this region The former is common

along the Hokkaido coast, and in 1929 Professor Hikita collected a specimen of *Kareius* at Oshoro for the senior writer

Matsushima Bay (collection secured in the fish markets at Sendai and Shiogama, September 3–7, 1929, field number, H29-295a) one hybrid 236 mm in standard length, collected with five specimens of *Kareius* and one of *Platichthys*

Off Kinkazan (collection obtained in the markets of Shiogama and Sendai, September 3–7, 1929, field number H29–295b) 15 hybrids, 191 to 357 mm long, taken with 10 specimens of *Kareius* (all preserved) and 7 examples of *Platichthys* In addition, 370 other individuals of *Platichthys* were examined fresh to determine that the left side of all carried the eyes and color, that stellate prickles were constantly developed on the eyed side (though they varied much in size and number), and that all had stellate prickles along virtually the entire length of the dorsal fin base All but one of the fifteen hybrids were found on the dock market at Shiogama as the fish were being unloaded from small craft, which had been fishing with *teguri-ami* (a type of trawl) Japanese helpers (zoology assistants of Tohoku Imperial University, kindly furnished by Professor Shinkishi Hatai) asked each crew where they had made their catch, and we thus learned that almost all boats fishing at depths of 20 to 25 fathoms had caught at least one hybrid It was therefore obvious that the hybrids were relatively common and well distributed over the trawling ground off Kinkazan The hybrid specimens varied widely in size (from 191 to 357 mm. in standard length; see also Table I, for the size classes of the specimens preserved), and surely represented more than one age group Therefore the seventeen hybrids taken

TABLE I

SIZE GROUPS OF JAPANESE SPECIMENS OF HYBRID FLOUNDERS AND OF THE PARENTAL SPECIES

	Standard length in millimeters									No
	0–49	50–99	100–149	150–199	200–249	250–299	300–349	350–399	400–449	
Kareius bicoloratus	2	19	11	36	11	2		2		83
HYBRID	1	1	1	6	6	4	4	1	1	25
Platichthys stellatus	2	6	15	26	9	5	2			65

in this region in five days cannot be attributed to a single brood and are probably not the result of any very local production

Off Kinkazan (collection obtained in the markets of Shiogama and Sendai, September 3–7, 1929, field number H29–295c) one large adult hybrid, 427 mm long, taken with three adults of *Kareius* but none of *Platichthys* This series was collected by the *teguri-ami* boats at a greater depth (about 60 fathoms), perhaps beyond the ordinary bathymetric limits of *Platichthys stellatus*, which throughout its range is essentially an inshore, more or less estuarine fish

Hachirô-gata, a large brackish lake in Akita-ken, near the coast of the Sea of Japan (sample taken in the Akita fish market, August 21–22, 1929, field number H29-260) one small specimen, of 58 mm, taken with eleven specimens of *Platichthys* but none of *Kareius* (both genera, however, are included in a collection secured at the same time from a trawl fishery operating near by in the Sea of Japan in about 25–80 fathoms, between Henashi-zaki and Oga Peninsula) This hybrid specimen, like the others listed below, was not recognized as such in the field

Hachirô-gata, at Funagoshi (collection obtained July 5, 1929, and presented to the senior author by the Tsuchizaki Fisheries Experiment Station, field number H29–262) one young hybrid, 35 mm long Apparently the young hybrids tend to follow *Platichthys* into the brackish waters (the young of *Platichthys* often live in fresh water, as do the adults occasionally, even where it is rapidly flowing near the mouths of creeks and rivers) The young of *Kareius* would seem to be more rigidly restricted to salt water

Sea of Japan, close to Niigata (these fish were found in the Niigata market August 18–20, 1929, but inquiry was made as to their source, field number H29–255) four hybrids, 147 to 171 mm long, preserved with eleven specimens of similar size of *Platichthys* and one of *Kareius* (the ratio of specimens is not significant, since these hybrids were not distinguished in the field)

Two additional hybrids, 234 and 240 mm long, are in the Chosen Fisheries Experimental Station at Fusan They were collected by the late Dr. Yojiro Wakiya "somewhere in Japan," and have been studied in Japan by the junior author One of these was reported as *Platichthys stellatus* (Anonymous, 1936)

During the collecting in 1929 *Kareius* and *Platichthys* were taken together, but without hybrids, in the harbor at Same-Minato, and

on the Pacific coast of Aomori-ken, both near the northern end of Honshyû. Both genera were also captured, though not in identical collections, in Toyama Bay in the vicinity of Namerikawa, and along the shore of Noto Peninsula These Japanese localities are indicated on our map (Fig 2)

It is evident from the field data that there is an overlap between the ecological as well as the geographical ranges of *Platichthys stellatus* and *Kareius bicoloratus* There are indications that the large hybrids descend offshore to depths greater than those inhabited by *Platichthys*, and that the young ones enter brackish waters which seem to be shunned by *Kareius* All *Kareius* × *Platichthys* specimens, however, were taken in habitats occupied by at least one of the parental species

Furthermore, there appears to be no temporal barrier to hybridization between *Kareius bicoloratus* and *Platichthys stellatus* According to the researches of Hikita (1934), the spawning season of the two genera (February and March) coincides in the waters of Hokkaido Adult males and females of both species, taken with 17 hybrids in the vicinity of Matsushima Bay and Kinkazan on September 3–7, have well-developed gonads, ripened to approximately the same degree Unfortunately there are almost no available data on the precise spawning habits of either parental species

Possible Partial Fertility of the Hybrids

The well-developed gonads, the even sex ratio (1 male to 1 female in Hikita's series of two, and 11 males to 12 females in the twenty-three half-grown to adult hybrids at hand), and the variable intermediacy of the characters as shown below, all suggest that the *Kareius* × *Platichthys* hybrids may be at least partly fertile The indications that one specimen may represent a backcross with *Platichthys* checks with this idea

Taxonomic Relationship between Parental Species

It seems obvious that we are dealing with an interspecific hybrid, for no ichthyologist would deny that *Kareius bicoloratus* and *Platichthys stellatus* are distinct These species differ in matters of kind as well as degree, and the differences pervade them throughout; in the sense of Goldschmidt (1940) they are "good species," with distinct "reaction systems" Whether we have before us an inter-

generic as well as an interspecific hybrid is, of course, a question that involves taxonomic judgment In his excellent systematic revision of the flounders Norman (1934 376) has combined *Kareius* with *Platichthys*, and hence in his view the hybrid under treatment is only interspecific We prefer, however, to maintain *Kareius* Jordan and Snyder (1900 379) as a distinct genus — closely related to *Platichthys*, to be sure, but perhaps, as most recent authors have indicated, with a relationship quite as close to *Liopsetta* In maintaining *Kareius* as a separate genus we agree with the systematic decision expressed in the treatises by Schmidt (1904 243–244), Jordan and Starks (1906 220–221), Tanaka (1913 192–195, pl 52, fig 198), Hubbs (1915 488), Jordan and Hubbs (1925 300), Soldatov and Lindberg (1930 410), Wu (1932 10 13, 17, 31, 33, 37 38, 42, 44, 55–56, 62–64, 71, 116–118, figs 1–3, 25), Hikita (1934 10, 193–197, pl 3, fig 5, and pl 10), Okada, Uchida, and Matsubara (1935 242, pl 142, fig 3), Taranetz (1938 121, 129, fig 5), and all other recent ichthyologists who have specialized in the study of Japanese and Chinese fishes

That *Kareius bicoloratus* possesses very distinctive characters has been demonstrated by the authors just cited, and also by Steindachner (1870b 628–629, pl 2), in his detailed description of *Pleuronectes scutifer* The treatment by Wu is particularly thorough Most of the authors cited have indicated by their descriptions, if not by direct comparisons, that *Kareius bicoloratus* differs sharply from *Platichthys stellatus* Excellent figures of Asiatic specimens of *Platichthys* were included by Soldatov and Lindberg (1930 409–410, fig 63), Tanaka (1931 123, col fig 308), Hikita (1934 10, 197 201, pl 3, fig 4, and pl 11), and Okada, Uchida, and Matsubara (1935 243, col pl 143, figs 1–2), and Okada and Ikeda (1938 120–121, 139, fig 16).[1] We present figures of *Kareius bicoloratus* and *Platichthys stellatus* (Pls I–II) from the region of Kinkazan and Matsushima Bay, where most of the hybrids (Pls II–IV) which we have studied were taken

[1] In this connection it may be pointed out that Jordan and Starks (1906 218–219, fig 19), in their review of the Japanese flounders, copied Jordan and Evermann's (1898 2651–2652, 1900 3311, pl 381) description and figure of *Platichthys stellatus* The same figure, based on an Alaskan specimen, was recopied by Jordan, Tanaka, and Snyder (1913 330, fig. 278) and by Tanaka (1936 263, 1 fig) The first description, still one of the best, of an Asiatic specimen of *Platichthys stellatus* was that of Steindachner (1870a 421–422)

Characters of the Hybrids

The *Kareius* × *Platichthys* hybrids were recognized as such by the circumstance that they resemble both genera in all respects in which *Kareius* and *Platichthys* are alike, and are intermediate in all characters by which the presumed parental genera differ Some of the features (see Pl II) were very apparent in the field, but others became obvious only after counts and measurements had been made and analyzed in the museum Still other trenchantly intermediate characteristics were not discovered until the specimens were subjected to closer scrutiny, and until internal characters were dissected Each new character which has been studied has added confirmation to the view that we are dealing with interspecific hybrids - until, in our minds, the last vestige of doubt as to the correctness of this interpretation has been dispelled

Before contrasting the cross-bred flounders with the parental species we wish to point out that the hybrids agree with both forms in all respects in which they correspond with one another Referring to the analytical criteria given by Norman (1934 282–286), we note that the following features (in addition to all characters, so far as they are apparent, assigned by him to the family Pleuronectidae) are all shared by the hybrids with *Kareius bicoloratus* and *Platichthys stellatus*

Pelvic fins short-based, symmetrical, supported by the pelvic bones behind the cleithra, pectoral radials present Origin of dorsal fin above the eyes, behind nasal organ of blind side, praecaudal parapophyses separate, divergent, hypocoracoid narrowed forward below Lateral line well developed on both sides of body, olfactory laminae parallel, without rachis Mouth smaller, maxillary of ocular side less than ¼ head Teeth larger, obtuse uniserial

The characters of the pyloric caeca, the lower pharyngeal arch, the squamation, and the head tuberculation, introduced by Norman in his key to the pleuronectine genera, are all different in *Kareius* and *Platichthys*, and hence are dealt with below

The hybrids also agree with *Kareius* and *Platichthys* in other characters, such as those utilized in the key by Jordan and Goss (1889 234), which was copied by Jordan and Evermann (1898 2607–2608) and by Jordan and Starks (1906 165–166) Thus the vertebrae and the dorsal and anal rays are in moderate number [2]

[2] Incidentally, the numbers given for *Platichthys* by Jordan and his associates are lower than the stated limits for the subfamily to which the genus was referred

(pp 291–294), the lateral line lacks the anterior arch and the accessory dorsal branch, and the body (except in the young) is devoid of any regular or normal squamation In correlation with the lack of an ordinary investment of scales the skin is very leathery

We conclude that the hybrids share with *Kareius* and *Platichthys* all known characters that are common to these genera In all the numerous features by which *Kareius bicoloratus* and *Platichthys stellatus* have been found to differ the hybrids are intermediate

SIZE

It is probable that the hybrids are of intermediate size (see measurements in list of hybrids) They are indicated in Table 1 as averaging larger than either parental species, but they are no doubt smaller in the run than *Platichthys*, which is generally regarded as one of the largest of the flounders All hybrid specimens seen in the field were preserved, despite their number and rather large size, but the specimens of *Platichthys stellatus* were selected Throughout its range that species is often as large as or larger than the largest hybrids When the hybrids were recognized all available specimens of *Kareius* were preserved Hence their smaller average size, as compared with the hybrids, is probably significant In his monograph on Chinese flounders Wu (1932 118) gave 325 mm as the maximum total length for *Kareius bicoloratus*

COLOR

Well-preserved material from the vicinity of Kinkazan and Matsushima Bay (Pl II) indicates that the hybrids are not so pale as those of *Kareius* nor so dark as those of *Platichthys* The senior writer's field notes on the fresh colors of the hybrids are as follows

> They vary from the pale dirty yellowish amber of *Kareius* to the olive-slaty or purplish slaty of *Platichthys*[8] The fins often have more yellow or orange than in *Kareius*, as much as in some specimens of *Platichthys* though not so much as in the examples of that genus with the brightest fins The fin markings are intermediate in that they are smaller and less black than in *Platichthys stellatus*, but some hybrids approach that species in this color feature

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[8] Incidentally, it should be mentioned that the colored figures of the hybrids and the parental species which have appeared in the Japanese literature (references above) are not true enough in color to indicate the intermediacy of the hybrids in this respect

The markings on the vertical fins provide the most striking first-glance distinction between *Kareius*, the hybrids, and *Platichthys*, and this character gradient is perhaps accentuated in preserved specimens (Pl II) The fins of the young of *Kareius* have faint mottlings of light and dark, which almost wholly disappear with age In *Platichthys* the fins are crossed by almost jet-black bands, which parallel the rays, occur on both sides of the fins, and often extend across the dorsal and anal bases onto the otherwise white blind side of the body, the bands on the caudal fin are similar, but usually do not reach the base of the fin. In the hybrids these markings are smaller and less barlike, and often appear rather as mottlings, which are dusky instead of black The general pattern, however, is the same, as is the number of markings four to ten on the dorsal fin, four to seven on the anal, only a few on the caudal

TUBERCLES ON THE EYED SIDE

In the next most obvious external difference between *Kareius* and *Platichthys*, namely, the tuberculation of the body, the hybrids likewise clearly exhibit their origin This is true for both surfaces of the body

Tubercles on the Eyed Side of Kareius

On the ocular side the tuberculation of *Kareius* and *Platichthys* is enormously different, except in the weakly scaled young In *Kareius* the body in the half-grown and the adult is smooth and scaleless, save for certain rows of tubercles [4]

1 The most conspicuous of the rough dermal ossifications form a dorsolateral row, along the line where the neural spines and interneural bones meet This row (irregular or partly doubled or even trebled in some specimens) is best developed over the trunk and varies greatly in thickness and length Its component elements occasionally appear in part as rounded stellate tubercles, but tend to form large rough, bony warts having an outline reminiscent of rhombic ganoid scales A nearly solid elongate mass is often produced This row is rarely lacking in the half-grown fish or the adult.

[4] The gross anatomy and arrangement of the spinulose osseous plates in the adults of *Kareius bicoloratus* have been described by various authors quoted above, in most detail by Wu (1932 10–13, figs 1–3), who also treated the histology of these hypertrophied scales Jordan and Hubbs (1925 300) described the ontogeny of the aberrant squamation in *Kareius*

2 In the ventrolateral row of tubercles, extending along the contact between the hemal spines and the interhemals, the elements are more commonly large rounded spiny tubercles, but in some fish these tend to fuse or enlarge to resemble the parts of the dorsolateral row Not infrequently the ventrolateral scutes are very few, rudimentary, or even entirely absent The row may be irregular, doubled, or even trebled

3 A series of elongate bony scutes (rudimentary in some, large and wartlike in others) is frequently laid down along the narrow dermal groove which lies just above and runs parallel with the lateral line These are often entirely lacking, even in large adults

4 Somewhat less frequently similar ossifications occur in the corresponding groove just ventral to the lateral line These scutes of rows 3 and 4 are not to be confused with the more or less enlarged stellate tubercles which in *Platichthys* form one or more rows on either side of and parallel to the lateral line, for those tubercles lie outside the rudimentary grooves accompanying the lateral line

5 A more or less irregular row of stellate tubercles, occasionally swollen into bony warts, runs along the dorsolateral edge of the caudal peduncle in many specimens These tubercles may be reduced to one or a few, and are often entirely lacking

6 With less frequency, or to a lesser degree of development, similar tubercles form a ventrolateral series along the colored side of the caudal peduncle

7 One or two such structures are usually evident on the base of the pectoral fin

8 One to several are often formed just below and behind the pectoral fin Groups 7 and 8 are developed in apparent independence, for either alone or both may be present In one specimen a single tubercle is developed on the side of the breast

9–11 Three groups of similar spiny tubercles comprise the squamation of the eyed side of the head The first set lies on the interorbital ridge, and in a triangular area immediately behind the ridge The second group, along the preopercular margin, is most extensively developed dorsally The third set covers all or part of the opercle (but not the subopercle or the interopercle) The second and third groups are more or less conjoined in some specimens Any one of the clusters, rarely all three, may be obsolescent Other parts

of the head, such as the body away from scale rows 1 to 8, are wholly devoid of scales

No tubercles are ever developed in *Kareius* on the body near the base of the dorsal and anal rays, or on these rays

Tubercles on the Eyed Side of Platichthys

In *Platichthys stellatus* (beyond the smooth, very young stages) the squamation differs strikingly from that of *Kareius bicoloratus*, as shown in the various published illustrations of the two species as well as in our two figures (Pl I) The number and the roughness of the characteristic tubercles of *Platichthys stellatus* vary widely at each locality, and increase northward on both coasts (the race living above Kinkazan and Matsushima Bay, where the adult hybrids were obtained, is moderately rough) These structures, which replace the scales, are isolated from one another, and are stellate with small spines, like the less ossified of the plates on *Kareius* They form one to several rows more or less parallel to the lateral line, toward which they tend to be enlarged Toward the dorsal and anal fins the tubercles become smaller and weaker, and are commonly obsolescent in a wide strip adjacent to the row along the dorsal and anal fin bases The scutella are often enlarged in the region behind and below the pectoral fins, near the shoulder girdle, and on the breast Expanded and, in some fish, more or less fused platelets tend to form irregular series corresponding with rows 5 and 6 as described above for *Kareius*, along the dorsolateral and ventrolateral edges of the caudal peduncle Rows 1 and 2, which are characteristic of *Kareius*, are not represented in *Platichthys*, even by a clumping or an enlargement of tubercles in a corresponding position The entire length of the dorsal fin and of the anal fin in *Platichthys* is accompanied on the body by a row of spinose tubercles, which are rather regularly aligned and spaced, one opposite each interradial space (the arrangement may become irregular or even partly biserial near the front of the fins, and a few of the posteriormost tubercles are often rudimentary or obsolete) On the eyed side of the head similar stellate scale derivatives tend to be clumped in areas 9 to 11, as defined above for *Kareius*, but in addition are usually scattered over the cheek and probably always occur on the temporal region above the postocular ridge. They are commonly as well developed on the subopercle and interopercle as on the opercle

Tubercles on the Eyed Side of Hybrids

The hybrids (Pls III–IV) vary enormously in scutellation — far more than one would expect a species to fluctuate Some are almost wholly smooth, a few almost as rough as *Platichthys* But in this divergence we see variously developed the tubercle patterns of both *Kareius* and *Platichthys* The following analysis is based on twenty-five specimens, our twenty-three half-grown and adult fish and Hikita's two adults (as represented by his exquisitely detailed figures) We take up first the nine rows or areas of scutes in *Kareius*, as defined and numbered above, then follow with scale derivatives that are developed in *Platichthys* but not in *Kareius*

1 *Dorsolateral series* — This diagnostic feature of *Kareius* is more or less evident in twenty-four of the twenty-five larger hybrids, though it is always made up of large stellate tubercles rather than bony warts It would seem that the tendency to form tubercles is derived more from *Platichthys*, but that the location of the series is a *Kareius* character In nine examples the scutella of this more or less irregular series are the only ones developed between the basidorsal tubercles and the lateral line Of these nine, one (Pl III, Fig 1) has only one tubercle in the series The eight others (Pl III, Fig 2) have the series ranging from one third to the full body length Five specimens comprise an intermediate category, for in them the only other tubercles between the dorsal base series and the lateral line are (*a*) three near the lateral line anteriorly, (*b*) twelve following the course of the lateral line anteriorly and medially, (*c*) a group between series 1 and the lateral line posteriorly, (*d*) a cluster of eight between series 1 and the lateral line anteriorly, and (*e*) a group of six above the lateral line near the middle of the standard length and six others between series 1 and the lateral line posteriorly In ten hybrids the dorsal half of the body is more or less covered with scattered platelets from near the lateral line out to an irregular longitudinal clustering that evidently represents a positional effect of series 1 of *Kareius* In four of these ten there are additional tubercles, in varying number, between the anterior part of this clustering and the dorsal fin One of the most heavily tuberculate examples is pictured as Plate IV. The only hybrid exhibiting no trace of the dorsolateral series is very close to *Plat-*

ichthys in squamation and all other characters, and may well be a backcross.

2. *Ventrolateral series.* — The squamation below the lateral line of the hybrids is almost a mirror image of that above the lateral line, except that the tubercles are usually fewer. The specimen with only one scutellum in series 1 (Pl. III, Fig. 1) has none over the main part of the body below the lateral line. Others in the first category of nine have as few as three spiny scales in series 2, and one of the five in the intermediate category has only one in this series. Otherwise the agreement in the dorsal and ventral tubercle pattern is close. The one specimen (a possible backcross) with no trace of series 1 likewise exhibits no evidence of series 2.

3–4. *Lateral-line series.* — Traces of these series, diagnostic of *Kareius* though often undeveloped in that genus, were detected in ten of the twenty-five larger hybrids. The individual scutes remain subcircular and small, without the elongation and warty enlargement typically seen in *Kareius*. The degree of development is various: two have only one below (that is, in series 4), three have several above (series 3), one has one above and one below, one has two above and two below, one has two above and three below, one has eight above and two below, and one has many above and below. In the hybrids the groove in which these plates develop in *Kareius* is usually indistinct, never well developed, often imperceptible. It is barely or not at all evident in *Platichthys*.

5–6. *Dorsolateral and ventrolateral rows on the caudal peduncle (extending somewhat farther forward in some specimens).* — It is consistent with the hybrid interpretation that twenty-four of the twenty-five postjuvenile specimens have several to many hard tubercles in these two series, which are commonly developed in *Kareius* and typically evident too in *Platichthys*. The one variant in this respect is the possible backcross with *Platichthys* mentioned above; it has small weak tubercles in the dorsolateral row (5).

7. *Pectoral base.* — This area, which usually bears one or two tubercles in *Kareius* and a number of generally large ones in *Platichthys*, is naked in the two least-scaled hybrids, but bears from one to many scutes in all other specimens of our series. Hikita's figures show no pectoral-base scutes in one specimen, and only one in the other.

8. *Area just below and behind the pectoral base.* — As would be

expected, from one to many stellate tubercles appear in this region, in rough proportion to the total number of plates

9–11 *Head tubercles* — In some of the hybrids the head scales tend to be restricted to the three regions to which they are confined in *Kareius*, but in all except one a few to many occur also on the temporal region (at least just above the postocular ridge) and on the cheeks, subopercle, and interopercle In some the scutes are thickly and almost evenly scattered over the head, as in the most heavily armored specimens of *Platichthys* Variable intermediacy is again the diagnosis

The special scale features of *Platichthys* are also more or less evident in the hybrids As indicated above and as shown on Plates III–IV, the body scutes vary tremendously in number, and are sometimes about as well developed as in *Platichthys* In fish with many scales, and in some specimens with only a few, the tubercles near the mid-line tend (as in *Platichthys*) to form two series, one above and one below, but both definitely separated from, the lateral line The breast, which bears only one scute in a single specimen of *Kareius* examined, but is covered with enlarged scutes in *Platichthys*, is provided in all the hybrids with several to many large tubercles The region just behind the shoulder girdle, and intervening between the breast and the pectoral base (always naked in *Kareius*, but well armed in *Platichthys*), is scaleless in four hybrids and bears one to many large stellate tubercles in the twenty-one other specimens

In general, the body scutes, other than those of the lateral-line series (3–4), are either well developed or absent in the hybrids, as though a threshold of development were required for their realization This is usually evident, too, for the stellate tubercles along the dorsal and anal bases These are totally lacking in *Kareius bicoloratus*, but are developed nearly to completeness in *Platichthys stellatus* Instead of all or nearly all being partially formed in the hybrids, a variable number are well developed, typically without a trace of rudiments, so that each series ends abruptly posteriorly (this is occasionally not true on the eyed side, and is often untrue on the opposite side) The intermediacy seems to be primarily one of numbers — of presence or absence in varying proportion The situation is different in the *Platichthys flesus* × *Pleuronectes platessa* cross of Europe, in which the hybrids have scales along the

fin bases intermediate between the very strongly spined scales of these rows in the *Platichthys* and the smooth scales of *Pleuronectes* (Duncker, 1895 15–29, figs 6–14, Kändler, 1935 12, figs 1–2, and other authors) The dorsal series in the Japanese hybrids averages longer than the ventral one, and both are usually centered near the vertical where the body depth is greatest

In all four series of scutes along the dorsal and anal fin bases the number of elements varies beyond any reasonable expectation for a species (Table II) When the scutes are numerous they are generally more irregularly arranged than in *Platichthys* They are often more isolated from one another and more removed from the fin base, especially on the anterior part of the series, and tend to form a double row in some specimens (in which case some small scutes may encroach on the fin base) As a result of this irregularity, the scutes of the fin-base row and of the body may more or less grade into one another, and the counts, particularly when high, are not very precise There is evident, too, a tendency toward a cumulative increase in the count when the fin-base row is more or less doubled anteriorly This is especially true of the basidorsal series and helps to explain the overlap between the counts for the hybrids and *Platichthys* The number of stellate tubercles along the base of the dorsal and anal fins, on the eyed side, is almost exactly intermediate between the numbers developed in the parental species, in round numbers the average values for *Kareius*, hybrids, and *Platichthys* are 0, 30, and 57 for the basidorsal series and 0, 22, and 40 for the basianal row (Table II) The lesser development of the plates on the blind side is discussed below The high positive correlation in the number of tubercles of the different series along the fin bases and the tendency of those with the high counts to approach *Platichthys stellatus* in color and still other features strongly suggest backcrossing between the hybrids and that species

Small spiny tubercles appear on the longer dorsal and anal rays of two hybrids, 35 and 38 cm in standard length, and a single one is developed on a dorsal ray in a 21-cm example No such scales could be found in even the largest examples of *Kareius*, and, oddly, none appear on any of the *Platichthys* specimens from the same region (Kinkasan and Matsushima Bay). Probably larger adults in northeastern Honshyû will also be found to develop scutes along the fin rays It will be remembered, too, that this race of *P stellatus*

TABLE II

NUMBER OF STELLATE TUBERCLES ALONG BASE OF DORSAL AND ANAL FINS IN *KAREIUS BICOLORATUS*, HYBRIDS, AND *PLATICHTHYS STELLATUS*

The counts were made only on half-grown and adult specimens from Japan 62 of *Kareius bicoloratus*, 25 of hybrids, and 34 of *Platichthys stellatus*

	Along dorsal base		Along anal base		Total
	Eyed side	Blind side	Eyed side	Blind side	
Number of tubercles in individual hybrids	10	0	8	0	18
	7	0	11	0	18
	11		11		*
	11	0	14	0	25
	22	0	12	0	34
	19	0	16	0	35
	19	0	17	0	36
	19	9	17	4	49
	29	3	18	5	55
	28	3	26	4	61
	29		19		*
	30	5	22	5	62
	26	5	26	6	63
	34	2	24	3	63
	39	0	24	0	63
	28	8	23	10	69
	26	12	24	8	70
	36	18	16	15	85
	48	8	30	2	88
	31	25	25	12	93
	47	12	29	11	99
	54	24	30	13	121
	54	26	27	17	124
	55	16	40	14	125
	50	30	29	20	129
Limits of variation					
Kareius bicoloratus	0–0	0–0	0–0	0–0	0–0
HYBRIDS	7–55	0–30	8–40	0–20	18–129
Platichthys stellatus	52–65	43–65	33–45	30–46	170–212
Averages					
Kareius bicoloratus	0 00	0 00	0 00	0 00	0 00
HYBRIDS	30 48	8 96	21 52	6 48	68 91
Platichthys stellatus	57 40	52 39	39 70	38 67	188 16

* Data taken from Hikita (1934 pl 2)

is only moderately rough. In an example from Muroran, typical of the more rugose Hokkaido race, some scales of this sort line a few of the dorsal rays, and such scales are well developed on both dorsal and anal fins of specimens from southeastern and southwestern Alaska — both representing roughly tuberculate races. Apparently these scales are always confined to the eyed side.

TUBERCLES ON THE BLIND SIDE

The complete intermediacy of the hybrids (as individuals when all characters are considered and as a group when any one feature is taken into account) is particularly well shown by the scutellation of the uncolored surface of the body and head. The mode of inheritance of species characters is also illustrated very interestingly. Consequently this matter is subjected to a rather extensive analysis (Table III).

In the development of the dorsolateral and ventrolateral rows (1 and 2) of tubercles on the blind side of some specimens, the hybrids, in the light of the data, do not seem to be intermediate. Traces of the stronger, dorsolateral, row (1), diagnostically developed on the ocular surface of *Kareius*, appear on the blind side in a few specimens of this genus, but no trace was found of the ventrolateral row (2) on the uncolored surface of any. Nor does any trace of these rows appear on either side of *Platichthys*. Most of the hybrids have, on the blind side as well as on the ocular surface, at least a trace of the dorsolateral scutes, and six of the twenty-three examined have the ventrolateral row represented on the uncolored side. What appears to have happened is that the hybrids have inherited from *Platichthys* a tendency to form tubercles on the lower surface, and from *Kareius* the pattern of developing scutes in particular areas. They may be said to be genotypically but not phenotypically intermediate. Of course, we have in mind that the flounders remain potentially symmetrical throughout life. The bringing out on the blind side of the hybrids of the scutellar characters normal to the eyed surface of one parental species reminds us of the well-known capacity of flounders to develop pigment on the normally white side, when the lower surface is subjected to illumination (Cunningham, 1891; Osborn, 1940).

The slight development of the lateral-line tubercles of row 3 and the lack of row 4 on the blind side of the hybrids reflect the circum-

stance that these scutes, though diagnostic of *Kareius*, are often wanting or rudimentary on the eyed side It is in general true in species hybrids that characters which are undeveloped in one parental form and rudimentary in the other (like the minute barbel of many American cyprinids) tend to be lacking in the hybrids

Rows and groups (5–11) of tubercles which are developed on the blind side in both parental genera, though to a different degree, are also well expressed in the hybrids The general squamation of the uncolored surface of the body and of the caudal peduncle, lacking in *Kareius* but developed in *Platichthys*, is either absent or present in the hybrids, in about equal ratio However, in the usually coarse tuberculation on the blind side of the pectoral base and the region just below and behind this fin base, and of the breast and the strip just behind the shoulder girdle, the hybrids resemble *Platichthys* more closely than they do *Kareius*

The most striking divergence of the hybrids from a position of exact intermediacy lies in the number of tubercles developed along the dorsal and anal fin bases (Table II and Fig 3), on the blind side of the body On the eyed side the number of basidorsal and of basianal tubercles is almost exactly intermediate between the zero development in *Kareius* and the almost complete development (one for each fin ray) in *Platichthys* On the uncolored side of the hybrids, however, these tuberculations are often lacking, and on the average are only one sixth as numerous as in *Platichthys* The greater approach to *Kareius* may be explained as due to the additive effect of two genetic factors (1) the general tendency among flatfishes for such structures as tubercles to be less well developed or lacking on the blind side and (2) the gene or genes responsible for the total lack of these tubercles in *Kareius*

NUMBER OF VERTEBRAE

Since the dorsal and anal rays and the lateral-line pores of *Kareius bicoloratus* outnumber those of *Platichthys stellatus* (Table IV) and since the number of fin rays and vertebrae is positively correlated in flounders (Kändler, 1935 13–14, 19, Townsend, 1937 98–102, fig. 1), as in most other fishes, we looked for a difference between these species in the number of vertebrae That there is an average difference in the expected direction and that the hybrids are again intermediate seems to follow from the available data (see p 291)

TABLE III

DEVELOPMENT OF TUBERCLES ON THE BLIND SIDE OF SPECIES AND HYBRIDS OF FLOUNDERS FROM JAPAN

The counts were made on 62 specimens of *Kareius* longer than 100 mm, 23 of hybrids longer than 146 mm, and 27 of *Platichthys* longer than 170 mm

Tubercles	*Kareius*	HYBRIDS	*Platichthys* [a]
Row 1 (dorsolateral)			
Wholly lacking	54	5	27
1 or 2, minute to medium	4	1	
Few, rudiments [b]		1	
Many, rudiments [b]		5	
5, minute	1		
4 or 5, small to medium		2	
10 to 20, minute to small	3		
10 to 30, medium		9	
Row 2 (ventrolateral)			
Wholly lacking	62	17	27
1, medium		1	
11–18, small to medium		5	
Row 3 (just above lateral line)			
Wholly lacking	57	23	27
1–3, small and rounded	4		
Series, small and elongate	1		
Row 4 (just below lateral line)			
Wholly lacking	62	23	27
Row 5 (upper edge, caudal peduncle)			
Wholly lacking	56		
1 or 2, minute to medium	6	1	
Few to many, rudiments [b]		5	
Few to many, medium to large [c]		11	27
Many, large above and small below [d]		6	
Row 6 (lower edge, caudal peduncle)			
Wholly lacking	62		
Few, rudiments [b]		2	
Many, rudiments [b]		4	
Few to many, medium to large [c, e]		12	27
Many, large below and small above		5	

[a] The specimens of *Platichthys* used for this table were selected from those collected in northern Honshyû, since the Hokkaido race is much rougher

[b] The rudimentary nature of these tubercles is probably due to incomplete ontogeny, for the specimens so featured are among the smallest studied

[c] Allowance was made for apparently incomplete development in smaller fish In some of the larger specimens, especially on the ventral edge of the peduncle, most of the tubercles are weak All the tubercles in *Platichthys* lie on the edge of the peduncle there is no accompanying series of smaller embedded tubercles in line with rows 1 and 2

[d] The small tubercles, mostly or all embedded, extend forward a varying distance on the body as though comprising a disconnected posterior part of the dorsolateral and ventrolateral rows (1 and 2) of the body

[e] Often with some smaller ones above

TABLE III (*Continued*)

Tubercles	*Kareius*	HYBRIDS	*Platichthys*
Group 7 (pectoral base)			
Wholly lacking	62	6	
1–4, small to large[f]		17	27
Group 8 (behind and below pectoral)[g]			
Wholly lacking	62	3	
Rudimentary			2
1–5, medium to large		20	
2–many, medium to large			25
Group 9 (opposite interorbital region)			
Wholly lacking	62	9	
Slightly developed		13	2
Moderately developed		1	9
Well developed			16
Group 10 (preopercle)			
Wholly lacking	62	13	1
Slightly developed		9	9
Moderately developed		1	15
Well developed			2
Group 11 (opercle)			
Wholly lacking	62	14	1
Slightly developed		8	21
Moderately developed		1	5
Subopercle			
Wholly lacking	62	19	19
Slightly developed[h]		4	8
Interopercle			
Wholly lacking	62	19	5
Slightly developed[h]		3	12
Moderately developed[i]		1	9
Well developed			1
Temporal region			
Wholly lacking	62	16	5
Slightly developed[j]		7	15
Moderately developed[j]			7

[f] At least one of these tubercles is large in each specimen except in a few of the smallest ones, in which the tubercles do not appear to be fully developed.

[g] *This group often grades into the one (7) on the pectoral base, into those* of the sides of the body, and into those along the shoulder girdle The distinction of these areas is arbitrary

[h] Either a few hard tubercles or many rudiments are developed

[i] Either a few large stellate tubercles or a few small yet hard ones.

[j] These tubercles are mostly clustered just above the postocular ridge

TABLE III (*Concluded*)

Tubercles	*Kareius*	Hybrids	*Platichthys*
Cheeks			
Wholly lacking	62	22	13
Slightly developed		1	11
Moderately developed			3
Sides of body [k]			
Wholly lacking	62	11	
Few to many rudiments, or few, large and very thin, or[l] 1, large and rough, with or without rudiments		12	
Usually many[m] large rough tubercles along lateral line anteriorly, usually with rudiments or tubercles outward			27
Sides of caudal peduncle and often region just in advance thereof			
Wholly lacking	62	11	
Few, embedded rudiments		10	
Medium number, embedded rudiments			6
Many rudiments (mostly embedded)		2[n]	13
Few to many, rough near lateral line, many rudiments outward			7
Many, rough, over peduncle			1[o]
Breast region			
Wholly lacking	62		
Medium number, rudiments		2	
Few to many, large		21	27[p]
Just behind shoulder girdle			
Wholly lacking	62	8	
Few, rudiments		1	4
1-few, large (often with rudiments too)		14	23

[k] This area excludes rows and groups 1–8 and the shoulder girdle, the breast, and the caudal peduncle, and the region just in advance thereof

[l] In two specimens only

[m] One specimen has a single large tubercle on either side of the lateral line anteriorly, another has only a few above and a medium number below, all others have many rough tubercles

[n] One of these two specimens is the one earlier indicated as a probable backcross, the only hybrid with no trace of rows 1 and 2

[o] This is a common type farther northward on both sides of the Pacific

[p] The breast is almost completely covered by large rough tubercles in some specimens, and bears rudiments as well as large scattered tubercles in others

Number of vertebrae recorded for *Kareius bicoloratus*

11 + 26 = 37 (Wu, 1932 17 — Chinese material)
11 + 27 = 38 (three counts, two from specimens[6] trawled near Kinkasan, and one from the figure by Hikita, 1934 pl 10, fig 2, based on the skeleton of a fish from Hokkaido)

Number of vertebrae in hybrids

11 + 26 = 37 (two counts, from specimens collected near Kinkasan)

Number of vertebrae in *Platichthys stellatus*

12 + 23 = 35 (Jordan and Goss, 1889 227)
34 (count given by Jordan and Goss, 1889 296, and frequently repeated)
11 + 25 = 36 (from Hikita, 1934 pl 11, fig 2, based on the skeleton of a specimen from Hokkaido)
34 to 37, with mean at 35 3 (Townsend, 1936 19, based on 239 specimens from Washington and Alaska)
11 + 24 = 35 and 11 + 25 = 36 (in two specimens from near Kinkasan)

The average numbers of vertebrae as determined from all the available data are

Kareius bicoloratus 37 75
HYBRIDS 37 0
Platichthys stellatus 35 3

OTHER COUNTS AND MEASUREMENTS

The intermediacy of the hybrids is further indicated in every large series of counts and measurements that was made (Table IV) The relative position of the arithmetic means for each count and measurement is stated and graphed in Figure 3 Each average value for *Kareius* is computed as 0, and for *Platichthys* as 100, and the mean for the hybrids is located on this percentage scale, by a value which may be known as the "hybrid index" If the index is 50 per cent, the hybrid is exactly intermediate in this character, if the index is 25 per cent, the hybrid is three times closer to the one parental species (in this case *Kareius bicoloratus*) than to the other

A glance at Figure 3 will show that the hybrids tend to be intermediate in all characters, though the deviations of some of the indices from 50 per cent (exact intermediacy) is large The unweighted average for the fourteen characters thus analyzed is com-

[6] One of these specimens possessed a synostosis of the vertebral column definitely approaching that figured by Wu (1932 53, fig. 20) for *Verasper*

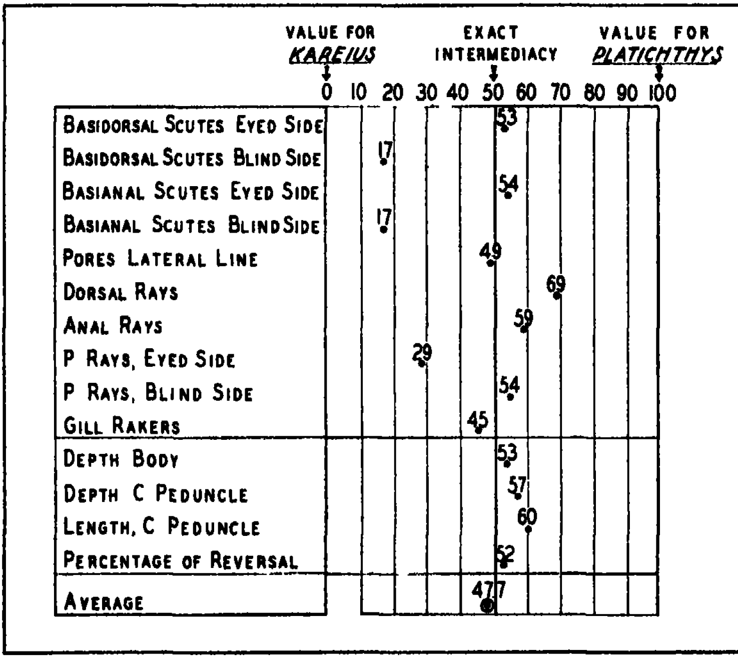


FIG 3 Chart showing, for all statistically analyzed characters, the average values ("hybrid indices") for the *Kareius* × *Platichthys* hybrids, on a percentage scale in which the averages for *Kareius* are set at 0 and those for *Platichthys* at 100

puted as 47 7 per cent, which indicates that in the ensemble of characteristics these hybrid flounders are almost exactly intermediate between their parental species

Since none of the frequency curves on which Table IV and Figures 3–4 were based show any obvious bimodity, it is virtually certain that the presumed hybrids are not a mixture of aberrant examples of *Kareius* and *Platichthys* Of course, such a mixture could give a hybrid index of about 50 per cent for any given character, and for all characters, but the specimens intermediate in one respect would not be likely to be so in other features The individual hybrid flounders here under treatment tend to be intermediate in all characters, as may be seen by inspecting Table IV and Figure 4

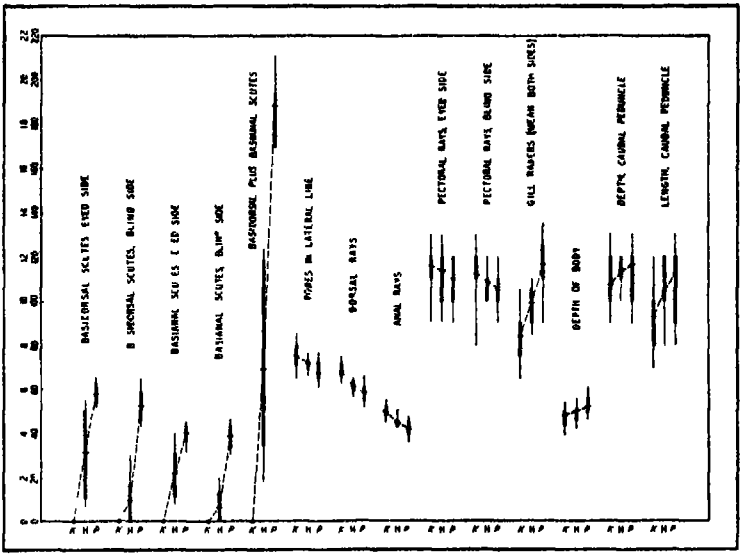


FIG 4 Graphic portrayal of the data in Table IV, to illustrate the intermediacy of the hybrids (H) between *Kareius* (*K*) and *Platichthys* (*P*) For each of these units there are shown the total range, the usual range ("80 per cent in range" figures), and the average

Plausible reasons can be assigned for the wide deviations of certain of the hybrid characters from exact intermediacy The greatest discrepancy, that for the number of basidorsal and basianal scutes on the blind side, has been explained (p 287) as probably due to the additive effect of two genetic tendencies Deviations less than 10 per cent may well be due to chance, and even greater deviations may not be significant, particularly when, as in the case of the pectoral rays, the means for the parental species are very close

We are tempted to suggest that the relatively low number of dorsal and anal rays in the hybrids (which causes a greater resemblance to *Platichthys* than to *Kareius*) may be due to heterosis, since high metabolic rates often seem to be related to a low number of segments (Hubbs, 1926). We note, however, that the hybrids in the Baltic Sea between *Platichthys flesus* and *Pleuronectes platessa* have vertebrae and fin rays averaging higher than the mean value

between the parental species, therefore approaching the *Pleuronectes* parent more closely than *Platichthys* (Kändler, 1935) Perhaps the most logical explanation is that in Japan the hybrids are back-crossing with *Platichthys*, in the Baltic Sea, with *Pleuronectes* This would be in line with the apparently greater abundance of *Platichthys* in the region of Japan where most of the hybrids were found, and of plaice on the flatfish grounds in Europe

The fact that the hybrids approach *Platichthys* more closely in the proportionate measurements may have resulted from some back-crossing, but probably has little significance The adults in these flounders have deeper bodies and deeper and longer caudal peduncles than the young, and *Platichthys* differs from *Kareius* in the same direction The fact that the hybrids average large (since all were preserved) suffices to explain their closer resemblance to *Platichthys*

The various deviations of the hybrid index from 50 fluctuate from the high to the low side, so that the average index, as noted above, is close to the line of exact intermediacy

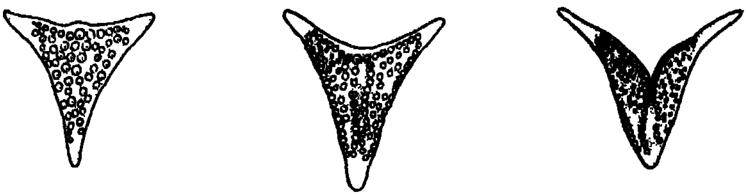
POSTOCULAR RIDGE

We have by no means come to the end of the list of characters in which the interspecific hybrids are intermediate between *Kareius bicoloratus* and *Platichthys stellatus* The postocular ridge is another of these features In *Kareius* this bony structure is more prominent than in *Platichthys* because it is free of scales, broader, flatter, and much more roughly sculptured with ridges and tubercles In *Platichthys* the ridge anteriorly is typically more or less covered by strong stellate tubercles, and is relatively narrow and smooth, its posterior end, however, rises in a rather trenchant keel or winglike tubercle (flattening with age) In all these respects the postocular ridges of the hybrids range almost from the one extreme to the other, and almost all specimens very obviously exhibit intermediate or combined characteristics

LOWER PHARYNGEALS

The lower pharyngeal arches and their dentition (Fig. 5) provided a striking confirmation of the hybrid interpretation, which we had postulated from earlier field and laboratory studies In the northern Honshyû race of *Platichthys stellatus* the pharyngeal arches and teeth are less modified than in other members of the

Liopsetta group with which *Platichthys* is generally associated (as by Jordan and Goss, 1889 234, Jordan and Evermann, 1898 2607–2608, Jordan and Starks, 1906 165–166, Hubbs, 1915 486, and Norman, 1934 286) The bones are united anteriorly for only about half their length, and each one is not much more than one fifth as wide as long, and the teeth are less broadened and molariform than in *Kareius* As is well indicated by Wu (1932 116, fig 25), the massive lower pharyngeals of *Kareius* are united for almost their entire length into a nearly solid mass, having the outline of an isosceles triangle and being provided with large molars



Kareius Hybrid *Platichthys*

FIG 5 Lower pharyngeal bones and teeth in Japanese specimens of *Kareius*, hybrids, and *Platichthys*

As shown in Figure 5, the arches and teeth of the hybrids are definitely intermediate in all respects The hybrids show considerable variation in the intermediate shape of the lower pharyngeals

ALIMENTARY CANAL

The intermediacy of the hybrids penetrates into the visceral anatomy Contrary to a key distinction used by Norman (1934 286), the pyloric caeca differ in *Kareius bicoloratus* and in the Japanese form of *Platichthys stellatus* In this race there occur 3 + 1 (rarely 2 + 1 or 3 + 0) caeca, in line with Norman's count (1934 46–47, 284, fig 28), whereas in *Kareius bicoloratus*, as in *Platichthys flesus* (Norman, 1934 377), there are 2 + 0 or 3 + 0 caeca The three appendages at the pylorus in the Japanese type of *Platichthys* are in definite positions (*A*) one at the outside of the pyloric bend is always well developed, finger-like, (*B*) one on the inner pyloric curve, and toward the eyed side of the body, is usually almost as well developed, occasionally rather small, (*C*) one

TABLE IV

COUNTS AND MEASUREMENTS OF *KAREIUS BICOLORATUS*, HYBRIDS, AND *PLATICHTHYS STELLATUS*

The specimens, all from Japan, have a size range shown in Table I The data on basidorsal and basianal scutes are taken from Table II, those on percentage of reversal, from Table V For the other characters all available specimens (listed in Table I) were utilized The data are graphed in Figure 4

	Kareius	HYBRIDS	*Platichthys*
COUNTS			
Basidorsal scutes, eyed side			
Extreme range	0–0	7–55	52–65
80 per cent in range*	0–0	11–50	53–62
Average	0 00	30 48	57 40
Basidorsal scutes, blind side			
Extreme range	0–0	0–30	43–65
80 per cent in range	0–0	0–16	47–59
Average	0 00	8 96	52 39
Basianal scutes, eyed side			
Extreme range	0–0	8–40	33–45
80 per cent in range	0–0	11–29	37–43
Average	0 00	21 52	39 70
Basianal scutes, blind side			
Extreme range	0–0	0–20	30–46
80 per cent in range	0–0	0–13	33–42
Average	0 00	6 48	38 67
Basidorsal plus basianal scutes			
Extreme range	0–0	18–129	170–212
80 per cent in range	0–0	34–124	170–194
Average	0 00	68 91	188 16
Pores in lateral line (from opposite upper angle of gill opening to base of caudal fin)			
Extreme range	65–85 †	67–76	61–76
80 per cent in range	71–80	69–74	65–72
Average	75 51	71 56	67 48
Dorsal rays (last ray double)			
Extreme range	63–75 †	57–65	52–66
80 per cent in range	66–72	59–64	55–61
Average	68 20	61 60	58 58

* The phrase "80 per cent in range" needs explanation The figures constitute a range including at least as many specimens as the number nearest 80 per cent of the total, after the most extreme variants have been deleted

† Similar counts are given by Wu (1932 117) for Chinese material of *Kareius bicoloratus*

TABLE IV (*Continued*)

	Kareius	HYBRIDS	*Platichthys*
Anal rays (last ray double)			
Extreme range	46–54 †	43–51	36–48
80 per cent in range *	48–52	43–46	39–45
Average	49 75	45 16	42 02
Pectoral rays, eyed side			
Extreme range	9–13	9–13	9–12
80 per cent in range	11–12 †	10–12	10–12
Average	11 61	11 44	11 03
Pectoral rays, blind side			
Extreme range	8–13	10–12	9–12
80 per cent in range	11–12 †	10–11	10–11
Average	11 28	10 88	10 54
Gill rakers on first arch (mean of both sides)			
Extreme range	6 5–10 5	8 5–11 0	9 0–13 5
80 per cent in range	7 5–9 0	9 0–10 5	11 0–12 5
Average	8 36	9 84	11 64
MEASUREMENTS IN HUNDREDTHS OF STANDARD LENGTH			
Depth of body			
Extreme range	39–54	42–56	46–61
80 per cent in range	43–50	46–51	49–56
Average	47 00	49 44	51 63
Least depth of caudal peduncle			
Extreme range	9–13	10–12	9–13
80 per cent in range	10–12	11–12	10–12
Average	10 76	11 26	11 64
Length of caudal peducle ‡			
Extreme range	7–12	8–12	8–13
80 per cent in range	8–10	10–12	9–12
Average	9 24	10 42	11 21
PERCENTAGE OF REVERSAL			
Number counted	83 +	27	476
Percentage	0	52	100

‡ Measured along the mid-line from the caudal base to a line joining last rays of dorsal and anal fins

on the same curve, but toward the blind side, is always smallest and may be much reduced (lacking in one of about twenty specimens examined) In *Kareius* these caeca are in corresponding position and are developed in the same size gradient, but are almost always shorter and blunter, typically the two main ones (*A* and *B*) are mere rounded protuberances at the pylorus, but *A* and sometimes both *A* and *B* are occasionally finger-like, in which case *C* may be developed as a minute to small evagination In the Japanese *Platichthys* a fourth finger-like caecum (*D*), rarely very short, is developed (with rare exceptions) from the intestine, at some distance from the pylorus and along the line where the mesentery is attached No corresponding structure is evident in the specimens of *Kareius* dissected There are other differences in the alimentary canal In the *Platichthys* there is a greater differentiation between stomach and intestine, the intestine has a thinner wall and a smaller caliber, and it is more coiled, one loop lies between the pylorus and the body wall on the blind side of the fish in the *Platichthys*, but not in *Kareius* The general characters of the intestine as well as the caeca of *Kareius* were mentioned by Wu (1932 31, 33)

In the hybrids these characters of the alimentary canal, like all other known differential features, are intermediate The caeca at the pylorus number either two or three, but at least a trace of the smallest one (*C*) is usually developed The two main caeca are variably developed, and average smaller than in the *Platichthys* but larger than in *Kareius* The caecum (*D*) on the intestine varies from imperceptible to moderately well developed The intestinal characters of thickness, caliber, length, and degree of coiling are also transitional

The North American forms of *Platichthys stellatus*, at least those from central California, southeastern Alaska and the Alaskan Peninsula, usually have pyloric caeca more like those of *Kareius bicoloratus* or the hybrids than those of the Japanese races of *Platichthys stellatus* The number is usually 2 + 0, occasionally 3 + 0 or 3 + 1 Caeca *A* and *B* ordinarily vary from rounded elevations to short finger-like processes, caeca *C* and *D* when developed are rudimentary or very short

SIDE BEARING EYES AND COLOR

In some ways the most interesting feature in which the hybrids are intermediate is the side which bears the eyes (Tables IV–V).

For an unknown reason, in northern Japan *Platichthys stellatus* seems always to settle onto its right side, so that the left side comes to bear the eyes and color This constitutes a 100 per cent reversal, for the flatfishes of the family Pleuronectidae, to which *Platichthys* is clearly referable, are normally dextral Sinistral individuals are unknown in many pleuronectids, and in most others are so rare as to be thought of as teratologically reversed in asymmetry This subject was treated at some length, with references, by Norman (1934 27-29) and Gudger (1935) Both authors quoted our discovery of the uniform reversal of *Platichthys* in Japan, as well as our preliminary and inexact estimate of the degree of reversal in California and Alaska

A large array of published and original data (Table V) indicates (1) that *Platichthys* is particularly subject to reversal throughout its range, (2) that the percentage of reversal is a regional and racial character, and (3) that the race of southwestern Alaska seems to represent intergrades, in this respect at least, toward the regularly reversed Asiatic races The variation in *Platichthys flesus* of Europe is great and irregular (Duncker, 1900 339-340, Berg, 1932 3-7, Norman, 1934 28) On the west coast of North America, from central California to southeastern Alaska, the percentage of reversal in *Platichthys stellatus* ranges irregularly from 49 to 60 About Kodiak Island and the south shore of the Aleutian Peninsula 68 per cent are reversed For populations from the Bering Sea, Aleutian and Kamchatka regions, the data are too tenuous for safe estimates [6] Only in northern Japan are we confident that all-sinistral races exist Their subspecific nomenclatorial status remains to be determined

Kareius bicoloratus seems to be regularly and perhaps invariably dextral (that is, normal for a pleuronectid). We have only eighty-three specimens on which this statement has been checked, but most of the authors quoted earlier have described *Kareius* as dextral,

[6] The counts for "Kodiak Island and the Aleutian Peninsula" in Table V include one dextral and one sinistral specimen from Akutan Island near the base of the Aleutians, and three rights and five lefts from Naknek on Bristol Bay Scofield (1899. 509) recorded four specimens, all sinistral, from Port Clarence, near Bering Strait, Alaska (two of these have been reëxamined), but Rendahl (1931 19) reported three dextral and seven sinistral specimens from the same locality and Bering Island (of the Commander group, off Kamchatka) Three examined from Kamchatka are sinistral Several counts from Hokkaido, all sinistral, are included with those from Japan In his study of flounders from Hokkaido, Hikita (1934) described *Platichthys* as sinistral Most of the 476 counts

without a mention of reversed specimens, and all published figures (see p 275) show the right side colored Wu (1935 116–118) specifically stated "yeux à droite" and listed twenty-three specimens from China as having been examined

The twenty-seven known hybrids between the dextral *Kareius bicoloratus* and the invariably reversed (sinistral) Japanese races of *Platichthys stellatus* are as nearly equally divided as is possible in respect to the side bearing eyes and color thirteen are dextral and

TABLE V

DATA ON THE SIDE BEARING EYES AND COLOR IN CERTAIN FLOUNDERS

Based on the counts published by Lockington (1879 93), Scofield (1899 509), and Townsend (1937 94–97), and on original data

Species and locality	*Number of specimens examined*	*Percentage reversed (sinistral)*
Platichthys stellatus		
California *	509	55 2
Oregon, outer coast †	65	49 2
Columbia River mouth †	225	60 4
Washington, outer coast †	247	56 3
Puget Sound ‡	8,972	51 6
Southeastern Alaska §	2,498	58 2
Kodiak Island and Alaska Peninsula ‖	5,129	68 0
Japan †	476	100 0
Hybrids, *Kareius* × *Platichthys* †	27	52 0
Kareius bicoloratus †	83 +	0 0

* Counts original, plus 284 from Lockington (1879 93) as quoted by Townsend (1937 96)

† Counts all original

‡ Counts mostly furnished by the late E Victor Smith, supplemented by the figures of Townsend (1937 97) and by a few original counts

§ Counts original, mostly furnished through the kindness of Earl E Ohmer

‖ Data mostly from Townsend (1937 97), supplemented by numerous counts kindly made for us by Allan C DeLacy, and by a few other original determinations

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given for northern Japan were based on specimens from Matsushima Bay and off Kinkasan (where most of the hybrids were secured), but a considerable number of the determinations were made on specimens from various points throughout the known range of the species in northern Japan (p 270 and Figs 1–2) All published figures (see p 275) of Asiatic specimens show the left side colored A dextral individual of *Platichthys* was mentioned in a report of the Chosen Fisheries Experiment Station, but when reëxamined by the junior author, this specimen proved to be a hybrid.

fourteen are sinistral This is clear confirmation for the assumption, based on geographical variation, that reversal of sides is an hereditary phenomenon, perhaps involving, as does the direction of coiling in snails, some simple Mendelian segregation The interesting point in connection with the present discussion is that the hybrids are more or less precisely intermediate between the parental species in this developmental character, which seems to have, as its determining source, some fundamental peculiarity of the nervous system in the postlarvae

Summary

Numerous natural hybrids between species and even genera of fishes are known These are mostly from fresh water, but occur also in the sea In line with ecological expectation certain flatfishes (Heterosomata) are particularly wont to hybridize In the Bothidae and Pleuronectidae there are recognized five interspecific hybrids in Europe and one in Western North America All of these combinations are regarded by us as intergeneric

A new interspecific flatfish hybrid, *Kareius bicoloratus* × *Platichthys stellatus*, is recognized, from Japanese waters Like other natural hybrids in this and other families of fishes, it is intermediate in all characters and highly variable in some respects Its rare and sporadic occurrence also suggests its interpretation as a hybrid, and the available information on the geographical distribution, habitat selection, and breeding season of the presumed parental species in Japan is quite in harmony with this view It is suspected that the hybrids may be partially fertile *Kareius* is regarded as generically distinct from *Platichthys*, though closely related

The hybrids agree with *Kareius* and *Platichthys* in all features which these genera have in common, and are more or less precisely intermediate in all characters in which the genera disagree The features in which the hybrids are variably intermediate pervade the whole organism, and include size, general body color, and the markings on the fins, the complex arrangement, the number, and the degree of development of the modified squamation (bony plates, stellate tubercles, and rudimentary scales), on both sides of the body, head, and fin bases, the numbers of vertebrae, of lateral line pores, of dorsal, anal, and pectoral rays, and of gill rakers, the depth of the body, and the depth and length of the caudal peduncle,

also such internal differences as the shape and strength of the pharyngeal arches and teeth, the number of pyloric caeca, and the diameter and degree of coiling of the intestine, also the percentage of reversal (that is, of sinistral individuals) Like nearly all pleuronectids, *Kareius* is dextral (with eyes and color on the right side), but *Platichthys* in Japan is invariably reversed Of twenty-seven hybrids, thirteen are dextral and fourteen are sinistral

Not considering ordinal and family characters, which are of course held in common, we find at least twenty-one features, regarded as of subfamily or generic significance, in which the hybrids agree with both parental genera In sixteen of the respects in which *Kareius* and *Platichthys* differ the hybrids are intermediate but closely similar to both genera In no fewer than seventy comparisons the two parental genera are more or less trenchantly different, and the crossbred fish are intermediate In two of these comparisons the hybrids seem unlike either parent, for on the blind side they often have dorsolateral and ventrolateral scale rows which do not appear on this side of the body in either *Kareius* or *Platichthys* These rows are present, however, on the eyed surface of *Kareius*, so that in these exceptional features the hybrids may still be regarded as genotypically intermediate In one or two respects only the hybrids resemble one parental genus exclusively in that they lack characters which are developed, but to only a rudimentary degree, in the other parent The number of scutes along the bases of the dorsal and anal fin, on the ocular side of the body, diverge greatly from an exactly intermediate number, owing, we think, to the additive effect of two genetic tendencies — the factor responsible for the complete lack of the structures in *Kareius* and the general tendency in flatfishes for the rough scales to be more or less obsolete on the unpigmented side In the ensemble of all statistically analyzed characters the average hybrid index is 47 7 per cent, on a scale in which 50 per cent denotes exact intermediacy

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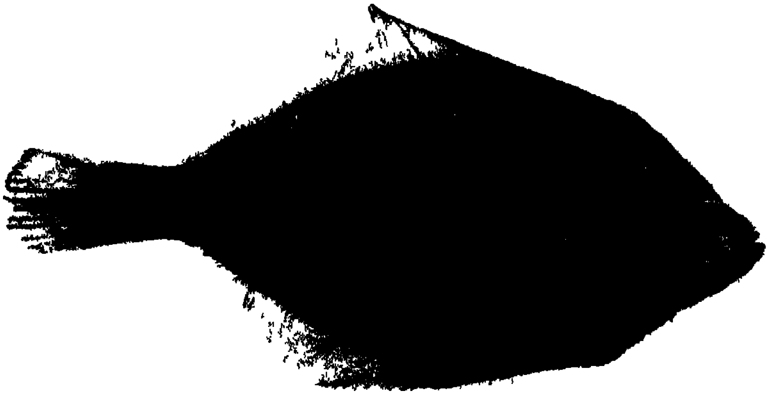


FIG 1 *Kareius bicoloratus*, from a typical specimen 249 mm in standard length, from off Kinkazan

FIG 2 *Platichthys stellatus*, from a specimen 227 mm in standard length, typical of the race occurring off Kinkazan

Kareius bicoloratus (left), hybrids (middle two), and *Platichthys stellatus* (right), from eyed and blind sides All adults (scale indicated by 15-cm ruler) from the vicinity of Matsushima Bay and Kinkazan

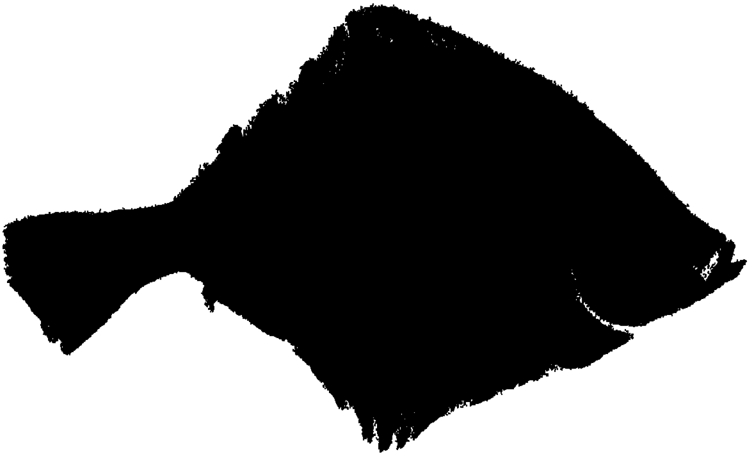
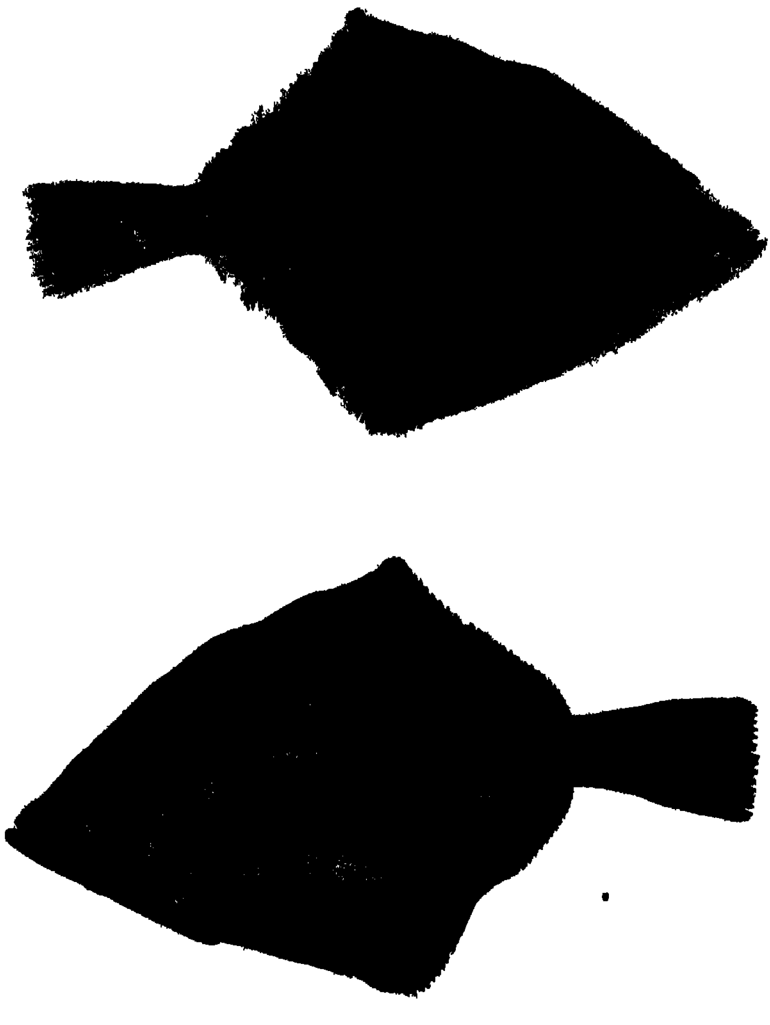


FIG. 1 The smoothest hybrid (*Kareius* × *Platichthys*), with only a single tubercle in the dorsolateral row, an adult 287 mm in standard length, from off Kinkazan

FIG 2 A *Kareius* × *Platichthys* hybrid with a moderate number of tubercles, chiefly disposed in the dorsolateral and ventrolateral rows, an adult 361 mm in standard length, from off Kinkazan



One of the most heavily tuberculate hybrids, an adult 320 mm in standard length, from off Kinkazan Both eyed and blind sides are shown On the blind side the tubercles are mostly confined to the dorsolateral and ventrolateral rows and to the upper and lower edges of the caudal peduncle

THE AGE AND GROWTH OF THE LAKE ERIE WHITE BASS, *LEPIBEMA CHRYSOPS* (RAFINESQUE)

JOHN VAN OOSTEN

I INTRODUCTION

ALTHOUGH the natural range of the white bass extends from New Brunswick and Minnesota southward through the St Lawrence River, the Great Lakes region, the Ohio and Mississippi valleys to the Gulf of Mexico, the greatest concentration occurs in the Lake Erie drainage In Lake Erie the species is restricted largely to the western end in Ohio waters, which yielded 92 per cent of the lake's commercial production (727,300 pounds, valued at $42,926) in 1938 (Only 8,400 pounds were produced in the other Great Lakes in 1938) More than three fourths of the Lake Erie catch is taken in the spring, mostly during the spawning period of the species in May and June About two thirds of this production is caught by trap nets

The available annual statistics of the commercial catch (Table I) reveal no evidence of a progressive decline in the abundance of the white bass in Lake Erie, although the yearly production shows considerable periodic fluctuations Some of the figures suggest cycles of abundance, a series of three good years being followed by four years of low yields Had the production of the years 1927–29 been high and of 1938 low, the cycles would have been consistent and uniform during the 26-year period The factors involved in the fluctuations of the catch are difficult to determine The cycles suggest that some natural cause exerted the dominating influence

Very little has been published on the age and growth of the fresh-water white bass Hile (1931) aged nine individuals collected from three Indiana lakes Thompson (1937) aged ten specimens taken from the Rock River of Illinois An anonymous article in *The Ohio Conservation Bulletin*, April, 1939, contains data on 617 white bass

collected in upper Sandusky Bay in Lake Erie in July and August, 1938 Of these fish 560 were aged Eddy and Carlander (1939) summarized very briefly the ages of 69 white bass taken from several Minnesota lakes Published statements indicate that the species may reach a maximum length of 18 inches and weight of 3 pounds.

TABLE I

POUNDS OF WHITE BASS PRODUCED ANNUALLY BY THE UNITED STATES COMMERCIAL FISHERMEN OF LAKE ERIE FROM 1913 TO 1938

Year	Pounds	Year	Pounds	Year	Pounds
1913	511,817	1923	300,200	1934	687,700
1914	478,210	1924	181,517	1935	739,300
1915	693,537	1925	232,000	1936	663,900
3-year average	561,188	1926	157,732	1937	435,100
1916	342,780	1927	121,124	1938	727,300
1917	332,778	1928	285,179	5-year average	650,660
1918	128,972	1929	155,327		
1919	193,347	7-year average	204,726		
4-year average	249,469	1930	483,696		
1920	504,444	1931	418,199		
1921	840,671	1932	252,695		
1922	821,307	1933	394,400		
3-year average	722,141	4-year average	387,248	26-year average	426,278

II MATERIALS AND METHODS

The materials used in this study were collected at several Lake Erie ports in Ohio and at Erie, Pennsylvania, in the years 1927–29 (Table III) A total of 1,869 white bass was aged, and 4,904 fish were used in the study of length-weight relationship The Ohio specimens were taken in trap nets, the Pennsylvania fish, in pound nets All length measurements recorded in millimeters and made with a steel tape and all weights recorded in ounces were obtained from fresh fish in the field Determinations of sex and stage of maturity were made for only part of the fish collected Ages are expressed by roman numerals and represent the number of annuli

found on the scales Measurements of the projected images of the scales were taken along the anterior radius

A study of the relationship between the length of the body and the magnified radius (scale × 40 7) of the scales used for the computation of growth was undertaken to determine whether or not there was a necessity for correcting the direct-proportion calculated lengths and, if such a correction was required, to find the method that would give the most accurate calculations of growth

The data were grouped into five-millimeter standard length intervals and the average body length, average scale measurement, and body-scale ratio (L/Sc) determined for each interval according to age and for all ages combined It was found that the L/Sc ratio tended to decrease (scale became relatively larger) not only as the length of the fish increased within an age group, but also as the age of the fish increased within a size group Only the data for all ages combined are given in Table II These showed a distinct tendency for the L/Sc ratio to decrease with an increase in the length (and age) of the fish This progressive increase in the relative size of the scale makes necessary a correction of the direct-proportion calculated lengths to obtain accurate results

The method for correcting the direct-proportion computed lengths was determined by plotting the averages of standard length and scale measurement of each five-millimeter length interval on coordinate paper and fitting a straight line to these data over the range represented by twelve or more individuals in each interval (range 110–244 millimeters, standard length) A line having an intercept on the "length" axis at 24 and a slope of 1 08 was found to fit closely the plotted data over the range to which it was applied (Fig 1) The plotted values for length intervals that included fewer than twelve fish likewise deviated but little from the straight line

The direct-proportion calculated lengths for age groups I, II, and III were corrected by the following formula

$$L_n = \frac{L - 24}{L} l_n + 24,$$

where L_n = corrected length at end of year n,
L = standard length at capture,
l_n = average direct-proportion calculated length at end of year n,
24 = point of intercept on "length" axis

TABLE II

Body–Scale Relationship (L/Sc) of 1,868 Lake Erie White Bass Arranged according to the Average Standard Lengths Based on Five-Millimeter Intervals, with All Age Groups Combined

Average standard length	Average scale measurement (× 40 7)	Average L/Sc ratio	Number of fish
97 2	65 9	1 47	4
102 0	78 3	1 30	3
107 0	80 5	1 33	4
112 0	81 8	1 37	13
117 5	88 6	1 33	32
122 3	92 3	1 33	46
127 0	96 0	1 32	52
132 0	100 5	1 31	59
137 0	104 7	1 31	49
142 0	110 4	1 29	61
146 9	114 4	1 29	67
152 2	118 6	1 29	76
157 0	121 1	1 30	91
161 9	127 8	1 27	142
166 6	130 2	1 28	126
171 8	134 7	1 28	159
176 7	139 6	1 27	124
181 6	143 0	1 27	83
186 4	147 6	1 26	68
192 0	154 7	1 24	66
196 9	158 7	1 24	70
202 0	166 9	1 21	88
206 6	170 9	1 21	69
212 0	174 4	1 22	74
216 6	180 0	1 20	67
222 1	182 1	1 22	49
226 6	189 4	1 20	31
231 4	192 0	1 21	23
236 6	196 9	1 20	20
241 8	201 2	1 20	12
246 2	210 0	1 17	9
251 9	207 4	1 21	9
255 8	221 0	1 16	4
261 0	216 7	1 20	3
267 0	214 5	1 24	2
273 5	227 8	1 20	2
277 0			
282 5	254 4	1 11	2
286 2	245 8	1 16	5
291 7	266 0	1 10	3
296 0	259 7	1 14	1
Weighted average		1 26	

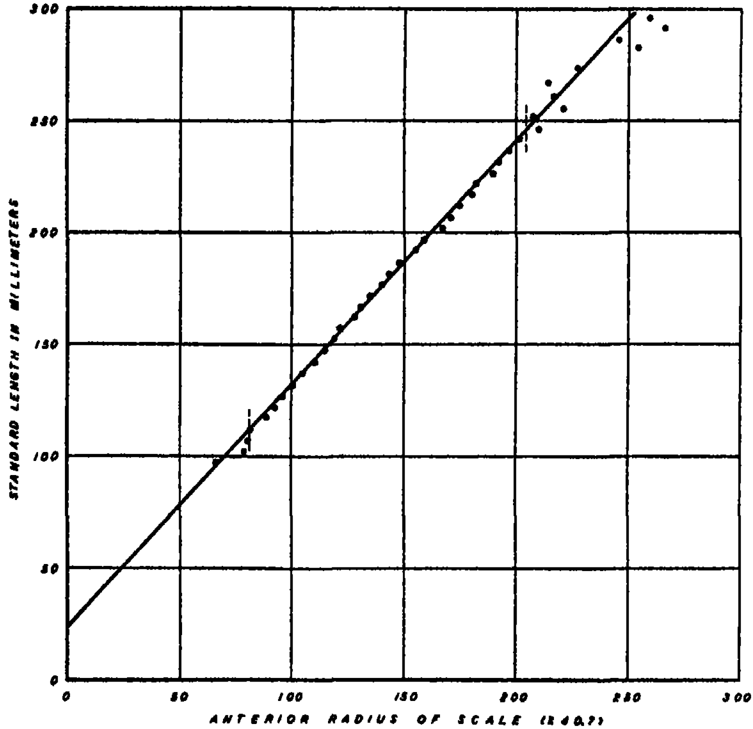


FIG 1 Body-scale relationship (L/Sc) of the Lake Erie white bass The two broken vertical lines indicate the length range over which the straight line was fitted The dots are based on the averages of Table II (See text for further explanation)

The use of average direct-proportion calculated lengths in the formula is valid, since lengths computed by direct proportion are in effect scale lengths, and their use makes unnecessary the recalculation of individual growth histories

The corrected calculated lengths for age groups IV, V, VI, and VII were obtained from the computation of individual growth histories, since each of these age groups contained very few individuals and the use of averages might introduce errors

I am greatly indebted to all the members of my staff for valuable assistance rendered in the preparation of this paper.

TABLE III

AGE COMPOSITION OF THE INDIVIDUAL AND COMBINED SAMPLES OF LAKE ERIE WHITE BASS COLLECTED IN 1927, 1928, AND 1929, USED FOR THE STUDY OF AGE AND GROWTH

Date of collection	Locality	Number of fish in age group 0	I	II	III	IV	V	VI	VII	0-VII
Oct 12, 1927	Sandusky, Ohio	11	366	4						381
Oct 21, 1927	Vermilion, Ohio	2	7							9
Oct 24, 1927	Sandusky Ohio		19							19
Oct 31, 1927	Sandusky, Ohio		30	1						31
Nov 5 1927	Sandusky, Ohio		17							17
Nov 9, 1927	Sandusky, Ohio		27	1						28
Nov 14, 1927	Sandusky, Ohio		51	2						53
Nov 21, 1927	Sandusky, Ohio	3	14							17
1927		16	531	8						555
Percentage composition		2 9	95 7	1 4						
Aug 10, 1928	Huron, Ohio		22	95	1					118
Aug 15, 1928	Huron Ohio		13	36						49
Aug 28, 1928	Huron, Ohio		46	115						161
Sept 5, 1928	Erie, Pa		35	136					2	173
Oct 8, 1928	Erie Pa		18	80	1	1		1	2	103
1928			134	462	2	1		1	4	604
Percentage composition			22 2	76 5	0 3	0 2		0 2	0 6	
July 1, 1929	Huron, Ohio		205	25	41	2			2	275
Aug 14, 1929	Lorain, Ohio		291		2					293
Sept 30, 1929	Erie, Pa		36	2	9			2	1	50
Oct 15, 1929	Erie, Pa		43	10	15		1	1		70
Oct 21, 1929	Erie, Pa		16	2	4					22
1929			591	39	71	2	1	3	3	710
Percentage composition			83 2	5 5	10 0	0 3	0 1	0 4	0 4	
1927 to 1929		16	1,256	509	73	3	1	4	7	1,869
Percentage composition		0 9	67 2	27 2	3 9	0 2	0 1	0 2	0 3	

III AGE COMPOSITION AND LENGTH FREQUENCIES

The age composition of the individual and combined samples of the Lake Erie white bass is given in Table III It is apparent that the samples of any one year are comparable irrespective of the date or the place of collection In 1927 nearly all (95 7 per cent) the fish belonged to age group I (year class 1926) Only 16 individuals out of 555 belonged to age group 0 and 8 to age group II (year class 1925) It would be of interest to know why older fish were not taken.

In 1928 no 0-group specimens were captured in the samples, either at Huron, Ohio, or Erie, Pennsylvania, and only 8 fish out of 604 were older than II The 1926 year class as II-group fish still dominated the catch with a percentage of 76 5 Age group I (year class 1927) comprised 22 2 per cent of the samples In 1929, however, the 1926 year class (age group III), although nearly twice as numerous as the 1927 brood, constituted only 10 per cent of the catch The I-group fish (1928 year class) dominated the samples with a percentage of 83 2 Again the 0-group was absent, and only 9 specimens out of 710 belonged to the older age groups (IV–VII)

The data show, then, that the 1926 year class was much stronger numerically than the 1925 or the 1927 year class, and that the 1928 brood was more abundant than the 1927 Attention may again be called to the fact that the 1926 year class also dominated for several years the Lake Erie catch of yellow perch, walleyed pike, blue pike, sauger, and sheepshead (Van Oosten, 1938)

In general, it may be stated that everywhere in Lake Erie the white bass population is composed of young fish Apparently very few individuals survive beyond their third full year In spite of the presence of the strong 1926 year class in 1929, only 4 7 per cent of the 1,869 white bass studied were older than three years, a few reaching their eighth summer That the paucity of old fish is due to intensive fishing cannot be asserted with certainty, although the three- and four-year-old white bass are still in the midst of their fast-growing period of life (p 319), which fact would seem to vitiate any assumption that the III-group fish had completed their life span Further, the majority of the fish do not begin to spawn until they reach the age of three years (p 329)

The length frequencies of the white bass (sexes combined — no great differences existed between them) taken in the fall of the year (September 30–November 21), when the last summer's growth was virtually completed, are given in Table IV An examination of the frequencies of age group I (the only group with sufficient number of specimens for comparison) for each year of collection separately showed that the range of the lengths of the Ohio and Pennsylvania specimens was the same, but that the eastern fish averaged about ten millimeters longer than the western It is believed, however, that a combination of the samples of all years gives a fairly accurate picture of the length distributions of the age groups

TABLE IV

LENGTH-FREQUENCY DISTRIBUTION OF THE LAKE ERIE WHITE BASS ACCORDING TO AGE GROUPS AND TEN-MILLIMETER INTERVALS OF STANDARD LENGTH (BASED ON A COMBINATION OF SAMPLES SECURED OCT 12–NOV 21, 1927, OCT 8, 1928, AND SEPT 30–OCT 21, 1929)

Standard length in millimeters	Equivalent mid-point, total length in inches	Age group									
		0	I	II	III	IV	V	VI	VII	0–VII	
										Number	Percentage
70–79	3 7	1								1	0 1
80–89	4 2										
90–99	4 7	1								1	0 1
100–109	5 2										
110–119	5 6	11								11	1 4
120–129	6 1	3								3	0 4
130–139	6 6		1							1	0 1
140–149	7 1		9							9	1 1
150–159	7 6		53							53	6 6
160–169	8 1		178	4						182	22 8
170–179	8 6		228	3						231	28 9
180–189	9 1		114	2						116	14 5
190–199	9 6		46	3						49	6 1
200–209	10 1		12	19						31	3 9
210–219	10 6		3	28	1					32	4 0
220–229	11 1			21						21	2 6
230–239	11 6			16	4					20	2 5
240–249	12 1			4	10					14	1 8
250–259	12 5			2	9					11	1 4
260–269	13 0				5					5	0 6
270–279	13 5					1		1		2	0 2
280–289	14 0						1	3	2	6	0 8
290–299	14 5								1	1	0 1
Total		16	644	102	29	1	1	4	3	800	

The lengths ranged from 75 to 295 millimeters, standard length, or from 3 7 to 14 5 inches, total length The mode of the combined samples occurred at the standard length of 175 millimeters (8 6 inches, total length), and corresponded with the mode of the I-group fish The average size of all fish was 9 inches, total length, and 87 per cent of the white bass varied between the 7 1- and 11 1-inch length intervals Approximately 62 per cent of the individuals taken in the impounding nets were below Ohio's legal size limit of 9 inches, total length

IV GROWTH IN LENGTH AND WEIGHT

Only the 1929 collections provide data on the differential growth of the sexes In 1927 all the mature white bass that were sexed were males, and sex could not be determined with certainty in the immature fish None of the 1928 specimens was sexed A comparison of the standard lengths, weights, and computed lengths of 263 males and 229 females of age group I collected at Huron (four fish not sexed) and Lorain, Ohio, in 1929 showed very slight differences between the sexes At both localities the females averaged 2 millimeters longer than the males at the end of the first year of life, and the average standard lengths and weights of the females exceeded those of the males by 2 and 4 millimeters and 0 11 and 0 28 ounce

Greater discrepancies existed between the less well represented sexes of the II- and III-group fish (24 and 41 specimens, respectively) In each group the females averaged longer and heavier The differences ranged from 6 to 13 millimeters and from 0 9 to 1 6 ounces However, the grand average calculated lengths of each sex of all age groups combined (285 males, 278 females) differed by only 1 and 2 millimeters in the first and second years of life and by 11 millimeters in the third The most adequate data indicate, then, that the females are only slightly larger than the males at corresponding ages A study of growth may, therefore, be based on the combined figures of both sexes

An examination of the average standard lengths of the fish of each age group for each date of collection indicated that no seasonal growth occurred after the middle of October The growth data collected in 1927 (see dates in Table III) may, therefore, be combined for all dates for each age group The I-group fish taken in 1928 at Erie, Pennsylvania, increased their average standard length 24 millimeters from September 5 to October 8, and the II-group individuals increased it 11 millimeters. Similarly, during the period July 1–October 21, 1929, the I-group white bass of Lake Erie apparently grew 61 millimeters, the II-group 39, and the III-group 22 To compare the actual lengths and weights of the fish captured in the three years and at different localities it is necessary that only the materials collected in late fall be employed, since the 1927 data were taken late in the season (Table V) Comparisons may also be made, however, for other seasons, provided that the dates of collection are approximately the same.

TABLE V

Average Length, Weight, and Coefficient of Condition (K) of the Age Groups of Lake Erie White Bass Collected in the Late Fall of 1927, 1928, and 1929

Age group	Locality	Year and period of collection	Number of fish	Total length (inches)	Standard length (mm)	Average weight (ounces)	Average weight (grams)	K
0	Sandusky, Vermilion, Ohio	Oct 12–Nov 21, 1927	16	5.5	112	1.08	31	2.15
I	Sandusky, Vermilion Ohio	Oct 12–Nov 21, 1927	531	8.4	171	4.15	118	2.31
	Erie, Pa.	Oct 8, 1928	18	9.0	183	5.39	153	2.43
	Erie, Pa	Oct 15–21 1929	59	9.1	185	5.47	155	2.41
	Grand average and total		608	8.5	173	4.31	123	2.32
II	Sandusky, Ohio	Oct 12–Nov 14, 1927	8	8.3	169	3.84	109	2.24
	Erie, Pa.	Oct 8, 1928	80	10.7	217	9.30	264	2.55
	Erie, Pa.	Oct. 15–21 1929	12	11.4	232	11.19	317	2.54
	Grand average and total		100	10.6	215	9.09	258	2.52
III	Erie, Pa.	Oct. 8 1928	1	12.4	252	14.50	411	2.57
	Erie, Pa.	Sept 30–Oct 21 1929	28	12.2	248	13.70	388	2.53
	Grand average and total		29	12.2	248	13.73	389	2.53
IV	Erie Pa.	Oct 8, 1928	1	13.5	273	15.25	432	2.12
V	Erie, Pa.	Oct. 15, 1929	1	14.1	285	19.25	546	2.43
VI	Erie, Pa.	Oct. 8, 1928	1	14.2	288	20.75	588	2.46
	Erie, Pa.	Sept. 30–Oct 15, 1929	3	13.8	281	19.33	548	2.43
	Grand average and total		4	14.0	283	19.68	558	2.44
VII	Erie, Pa.	Sept. 5–Oct 8, 1928	4	14.2	288	22.56	641	2.68
	Erie, Pa.	Sept. 30, 1929	1	14.1	285	19.50	553	2.39
	Grand average and total		5	14.2	287	21.95	623	2.62

The data of Table V indicate that the white bass of corresponding age groups averaged considerably smaller at Sandusky, Ohio, than at Erie, Pennsylvania For example, Ohio's minimum legal size limit of 9 inches, total length, was reached in the third summer of life by the Sandusky specimens, but at the end of the second summer by the Erie fish A comparison of the I-group fish taken in August (Table VI) shows that the specimens captured at Lorain, Ohio, in 1929 averaged smaller than those taken at Huron, Ohio, in 1928 It was also observed that age groups I and II taken at Huron in August, 1928 (Table VI), averaged larger than those collected at Erie in September, 1928 (not shown separately in Table VI) It appears, then, that no consistency existed in the discrepancies in the average lengths and weights of the fish from the two ends of Lake Erie

It may likewise be seen from Table V that the I-group fish captured at Erie in October, 1928 and 1929, agreed extremely well with respect to length and weight, but that the II-group individuals differed widely in the two years — the 1928 specimens were the smaller These inconsistencies in the average sizes of the fish collected in the different localities or at approximately the same time in different years suggest that no differential growth obtains among the white bass as the result of inhabiting various sections of the lake

The observed discrepancies in the average sizes of the fish collected in different areas or years are in part the results of a differential growth of the year classes, as indicated by the data of Table VI In this table the computed lengths and other information concerning the larger collections are arranged according to year classes It is to be noted that each younger year class shows an improvement in computed growth at all localities The 1925 year class is probably not well enough represented to be considered The first year's growth increased progressively from a grand average* of 90 millimeters in 1926 to 99 in 1927 to 107 in 1928 Whether this change had any connection with the unusual abundance of the 1926 year class (p 313) is not known, but other investigators have found a relation between growth and density of population At any rate, the small average size of the Sandusky fish is accounted for by the relatively slow rate of growth of the 1925 and 1926 year classes A similar explanation will account for some of the other discrepancies referred to above (p 317) It is possible, however, that the Huron

TABLE VI

STANDARD AND COMPUTED LENGTHS OF THE LAKE ERIE WHITE BASS OF THE LARGER COLLECTIONS ARRANGED ACCORDING TO YEAR CLASSES

Year class	Age group	Locality	Year and period of collection	Number of fish	Standard length (mm)	Computed length at end of year		
						1	2	3
1925	II	Sandusky, Ohio	Oct 12 Nov 14, 1927	8	169	90	136	
1926	I	Sandusky, Vermilion, Ohio	Oct 12-Nov 21, 1927	531	171	91		
	II	Huron, Ohio	Aug 10-28, 1928	246	206	90	169	
	II	Erie, Pa	Sept 5-Oct 8, 1928	216	210	89	161	
	III	Huron, Ohio	July 1, 1929	41	226	92	164	222
	III	Erie Pa	Sept 30-Oct 21, 1929	28	248	88	162	219
	Grand average and total			1,062		90	165	221
1927	I	Huron, Ohio	Aug 10 28 1928	81	165	98		
	I	Erie, Pa	Sept 5-Oct 8, 1928	53	167	99		
	II	Huron Ohio	July 1, 1929	25	194	103	182	
	II	Erie Pa	Sept 30-Oct 21, 1929	14	230	93	176	
	Grand average and total			173		99	180	
1928	I	Huron Ohio	July 1, 1929	205	128	116		
	I	Lorain Ohio	Aug 14 1929	291	149	102		
	I	Erie, Pa	Sept 30-Oct 21, 1929	95	181	104		
	Grand average and total			591		107		

fish actually grew somewhat faster than those of corresponding ages from Lorain and Erie

It may also be observed from Table VI that with few exceptions the comparable calculated averages agree fairly well within a year class, irrespective of the age group, locality, or date of collection that is involved These agreements substantiate the suggestion made above that with respect to growth the Lake Erie population of white bass is probably homogeneous Further, in studying the computed growth of a year class the dates of collection may be ignored and the growth materials combined

To obtain a general picture of the growth in length of the Lake Erie white bass we may combine all of our calculated-growth materials for each age group and for all age groups (Table VII and Fig 2) The white bass exhibits a typical growth curve which rises

TABLE VII

SUMMARY OF THE AVERAGE CALCULATED LENGTHS AND INCREMENTS OF LENGTH FOR EACH YEAR OF LIFE OF THE LAKE ERIE WHITE BASS COLLECTED IN 1927, 1928, AND 1929

Age group	Number of fish	Standard length (mm)*	Calculated length (mm) at end of year of life						
			1	2	3	4	5	6	7
0	16	112							
I	1,256	159	99						
II	509	207	90	166					
III	73	235	90	163	220				
IV	3	250	100	174	210	241			
V	1	285	111	200	249	266	279		
VI	4	283	102	188	230	250	266	275	
VII	7	289	103	178	230	255	268	276	283
Grand averages and total	1,869		96	166	221	252	268	276	283
Differences between calculated lengths (increments)			96	70	55	31	16	8	7
Equivalent total lengths in inches			4 7	8 2	10 9	12 4	13 2	13 6	14 0
Number of fish			1,853	597	88	15	12	11	7

* These lengths should not be used to indicate the average size of an age group since the fish were captured at various times of the year The more valid lengths are given in Table V

very rapidly in the first three years, then slopes gradually toward a straight line The greatest growth occurred in the first year (96 millimeters), followed by a progressive decline that lasts through the seventh year of life

In Table VIII are given the computed weights of the white bass that correspond with the grand average calculated lengths shown at the bottom of Table VII The equation employed for the computation of weights is given on page 322 These calculated weights presumably provide a more accurate picture of the general growth in weight than do the actual weights shown in Table V, since they are based on all age groups combined and represent completed years of life Both the total weights and increments of weight shown in Table VIII are plotted in Figure 3. In contrast to length, the weight

increased slowly during the first year The curve of total weight rises rapidly, however, in the second year, then more rapidly in the the next two years, after which it breaks and in the fifth year resumes approximately the slope of the second year, while in the last two years, though continuing the break, it still rises more rapidly than in the first year The greatest increment in weight occurred in the

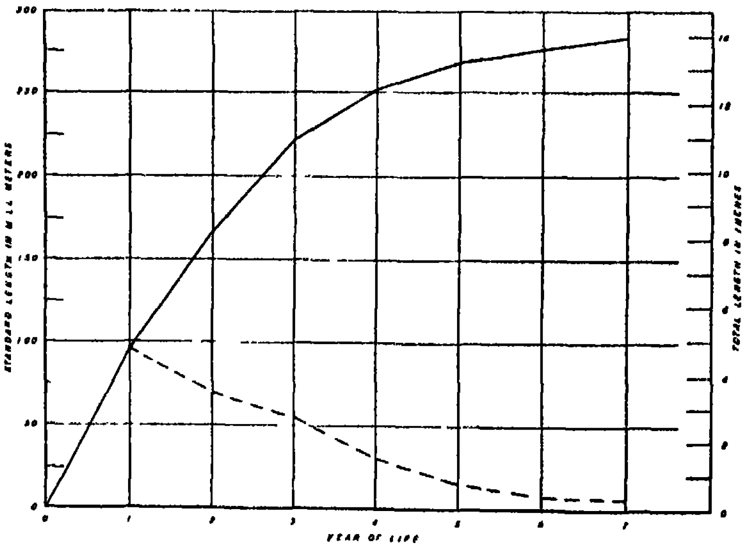


FIG 2 Growth curves of the Lake Erie white bass The solid line represents computed lengths, the broken line, computed increments of length The curves are based on the grand averages of Table VII

third year, and the smallest in the first On the basis of the increase in weight alone it would be economically sound to protect the white bass from capture until at least their fourth summer, after they have reached a total length of 11 inches (223 millimeters, standard length) Even in the fourth summer the fish added 4 8 ounces to their weight It is of interest to record here that also on the basis of attainment of sexual maturity a size limit of 11 inches is deemed desirable (p 329) On the Great Lakes no size limit exceeds 9½ inches in total length

TABLE VIII

CALCULATED WEIGHTS IN GRAMS AND OUNCES OF LAKE ERIE WHITE BASS CORRESPONDING TO THE GRAND AVERAGE CALCULATED LENGTHS OF TABLE VII, ANNUAL INCREMENTS OF WEIGHT, AND ANNUAL PERCENTAGE INCREASE IN WEIGHT

(See page 322 for the equation employed for the computation of weights)

Item	Year of life						
	1	2	3	4	5	6	7
Calculated weight (grams)	20	108	266	401	486	533	577
Increment of weight	20	88	158	135	85	47	44
Percentage increase		440	146	51	21	10	8
Equivalent calculated weight in ounces	0 70	3 81	9 38	14 14	17 14	18 80	20 35

V GROWTH COMPENSATION

To ascertain the relationship between the length of the first year and the later growth the white bass of several age groups were divided into three size classes based on the computed lengths at the end of the first year (Table IX) The average calculated length and increment of length were then determined for each size group for each year of life It may be observed from the table that each succeeding group of larger yearlings maintained the advantage of size throughout the three or four years compared, although in general the maximum differences between the groups diminished progressively with increase in age The increments of the second year were in close agreement and showed no decided trend in direction The third-year increments, however, reversed the trend of the first-year figures, and the smaller yearlings showed the better growth A compensation in growth seemed to have taken place during the third year

VI LENGTH–WEIGHT RELATIONSHIP AND COEFFICIENT OF CONDITION

The length–weight relationship of the white bass may be expressed by the following equation

$$W = cL^n,$$

where W = weight in grams,
L = standard length in millimeters,

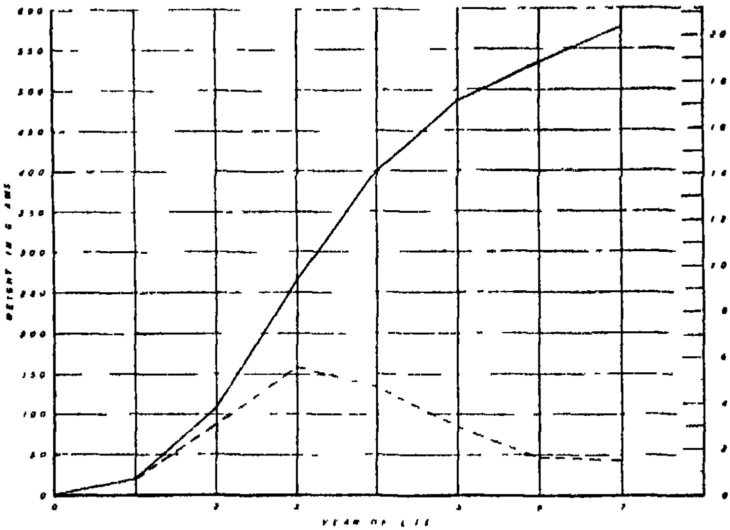


FIG 3 Growth curves of the Lake Erie white bass. The solid line represents computed weights, the broken line, computed increments of weight. The curves are based on the averages of Table VIII.

and c and n are constants, whose values are determined empirically by fitting a straight line to the logarithms of the average standard lengths and actual weights given in Table X. The equation was fitted to the average lengths and weights of fish between the limits of 103 and 261 millimeters, standard length (A and B on the curve of Figure 4). The resultant equation is $W = 1.206 \times 10^{-5} L^{3.132}$. The equation, in logarithmic form, is as follows

$$\log W = -4.9186623 + 3.132 \log L$$

The curve of Figure 4 was plotted from the standard lengths and calculated weights of Table X. The dots in the figure represent the length–weight relationship as based on actual measurements, which are also given in Table X. It is apparent from the figure, as well as from the differences between the actual and computed weights (column 7, Table X), that the calculated and empirical figures agree remarkably well when large enough numbers of specimens are employed. The equation may be used with confidence. The data

TABLE IX

RELATIONSHIP BETWEEN THE FIRST-YEAR LENGTH AND THE LATER GROWTH IN LENGTH OF THE LAKE ERIE WHITE BASS

Age group, date and locality of capture	Number of fish	Interval of calculated length, in mm, at end of first year	Calculated length at end of year of life				Calculated increment of length in year of life			
			1	2	3	4	1	2	3	4
II	29	Less than 86	80	158	204 *		80	78	46 *	
Aug 28, 1928,	40	86–94	90	170	212 *		90	80	42 *	
Huron, Ohio	46	More than 94	101	178	216 *		101	77	38 *	
	Maximum difference		21	20	12					
II	48	Less than 86	80	150	199 *		80	70	49 *	
Sept 5, 1928,	49	86–94	90	162	208 *		90	72	46 *	
Erie, Pa	39	More than 94	100	172	213 *		100	72	41 *	
	Maximum difference		20	22	14					
III	11	Less than 86	80	156	213	217 *	80	76	57	4 *
July 1, 1929,	15	86–94	89	160	220	225 *	89	71	60	5 *
Huron, Ohio	15	More than 94	105	177	231	235 *	105	72	54	4 *
	Maximum difference		25	21	18	18				

* Incomplete growing season

indicate that at the attainment of Ohio's legal length (9 inches) the white bass average 4 9 ounces in weight

Figure 4 has been drawn so that lengths may be converted readily from standard to total and vice versa, and weights from grams to ounces and vice versa The conversion of standard, fork, and total lengths or of lengths to equivalent weights has a practical value, since legal size limits of fish are stated in these various units of measurement in the different states The factors that may be used to convert the various lengths are given in Table XI A single factor is employed for each type of conversion, since no significant or consistent variation in the value was found with a change in the length of the fish

The coefficient of condition, K, is determined by the now well-known equation $K = \frac{W \times 10^5}{L^3}$, where W = weight in grams and L = standard length in millimeters A relatively large value of K

TABLE X

LENGTH-WEIGHT RELATIONSHIP OF LAKE ERIE WHITE BASS, BASED ON ACTUAL LENGTHS AND WEIGHTS OF 4,904 INDIVIDUALS TAKEN IN 1927, 1928, AND 1929

The average standard lengths are based on five-millimeter intervals, with sexes combined

Average standard length in mm	Equivalent fork length in inches	Equivalent total length in inches	Average weight in ounces	Average weight in grams	Calculated weight in grams*	Difference between actual and calculated weight in grams	K	Number of fish
93	4.3	4.6	0.6	18	18	0	2.19	2
97	4.5	4.8	0.7	21	20	−1	2.33	9
103	4.7	5.1	0.9	25	23	−2	2.28	13
107	4.9	5.3	1.0	28	27	−1	2.29	25
112	5.2	5.5	1.2	33	32	−1	2.32	59
117	5.4	5.8	1.3	37	36	−1	2.32	99
122	5.6	6.0	1.5	43	41	−2	2.36	135
127	5.9	6.3	1.7	48	47	−1	2.32	133
132	6.1	6.5	1.9	54	53	−1	2.33	159
137	6.3	6.8	2.1	60	59	−1	2.33	155
142	6.5	7.0	2.4	67	66	−4	2.34	148
147	6.8	7.2	2.6	73	74	1	2.29	167
152	7.0	7.5	2.8	80	82	2	2.28	198
157	7.2	7.7	3.2	89	91	2	2.31	240
162	7.5	8.0	3.5	99	100	1	2.33	300
167	7.7	8.2	3.8	107	111	4	2.31	319
172	7.9	8.5	4.2	118	121	3	2.32	359
177	8.2	8.7	4.5	128	133	5	2.31	320
182	8.4	9.0	4.9	140	145	5	2.31	299
187	8.6	9.2	5.4	152	158	6	2.33	245
192	8.8	9.5	5.9	167	171	4	2.36	168
197	9.1	9.7	6.6	187	186	−1	2.44	154
202	9.3	10.0	7.2	203	201	−2	2.47	143
207	9.5	10.2	7.7	219	217	−2	2.46	101
212	9.8	10.5	8.3	234	233	−1	2.46	121
217	10.0	10.7	8.9	252	251	−1	2.47	95
222	10.2	10.9	9.6	272	270	−2	2.49	121
227	10.5	11.2	10.3	291	289	−2	2.49	125
232	10.7	11.4	11.0	313	310	−3	2.50	100
237	10.9	11.7	11.7	332	331	−1	2.50	83
242	11.2	11.9	12.5	354	353	−1	2.50	90
247	11.4	12.2	13.2	376	377	1	2.49	81
251	11.6	12.4	14.0	396	396	0	2.50	58
256	11.8	12.6	14.9	424	421	−3	2.52	32
261	12.0	12.9	15.7	445	448	3	2.51	18
266	12.3	13.1	17.3	491	475	−16	2.61	4
273	12.6	13.5	18.0	510	515	5	2.51	4
278	12.8	13.7	18.2	517	546	29	2.41	2
282	13.0	13.9	19.5	553	570	17	2.46	1
286	13.2	14.1	20.8	589	596	7	2.52	5
292	13.5	14.4	21.1	597	636	39	2.40	5
297	13.7	14.6	19.9	565	671	106	2.15	3
302	13.9	14.9	24.2	685	707	22	2.49	2
308	14.2	15.2	25.6	726	752	26	2.49	2
310	14.3	15.3	27.5	780	767	−13	2.62	1
324	14.9	16.0	27.5	780	881	101	2.29	1

* Calculated by means of the equation, $W = 1.206 \times 10^{-[illegible]} L^{[illegible]}$

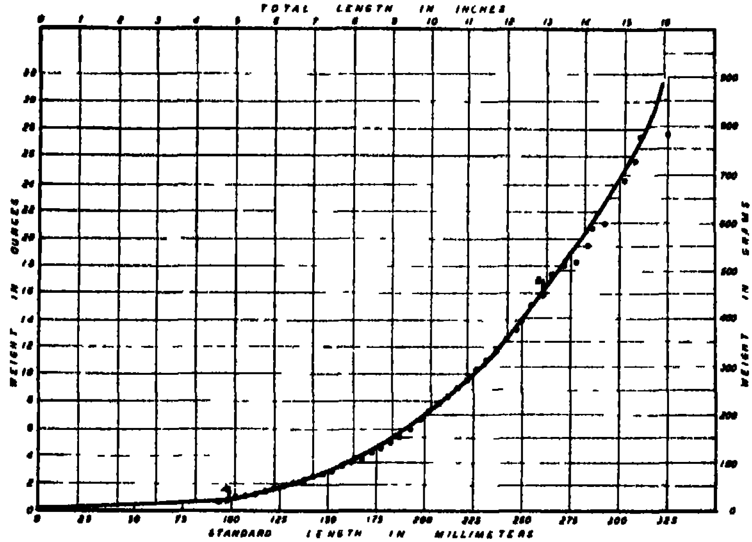


FIG 4 Length–weight relationship of the Lake Erie white bass The two vertical bars, *A* and *B*, indicate the length range over which the curve was fitted The dots are based on the average standard lengths and actual weights of Table X (See text for further explanation)

represents a good condition of the fish A comparison of the average *K* values of male and female white bass of corresponding age groups collected at the same locality and at the same time revealed no significant differences (0 00 to 0 08) between the sexes The two larger samples (201 and 291 fish of age group I), collected at Huron, Ohio, on July 1, 1929, and at Lorain, Ohio, on August 14, 1929, each showed a discrepancy of only 0 03 between the sexes The II-group fish (13 males, 11 females) captured at Huron, July 1, 1929, exhibited no difference, and the III-group specimens (9 males, 32 females) taken with the II-group differed by 0 08

No significant variations (greatest difference = 0 06) existed between the fish (sexes combined) of age groups I, II, and III collected at Huron, Ohio, on July 1, 1929 However, the specimens of age groups I and II, taken at Erie, Pennsylvania, in the fall (Table V) showed a discrepancy of 0 13, although no significant differences existed between the II- and the III-group fish (0 02) or between the

TABLE XI

FACTORS FOR THE CONVERSION OF STANDARD, FORK, AND TOTAL LENGTHS OF LAKE ERIE WHITE BASS, BASED ON ACTUAL STANDARD AND TOTAL LENGTH MEASUREMENTS OF 1,156 FISH BETWEEN 96 AND 267 MILLIMETERS, STANDARD LENGTH, AND ON STANDARD AND FORK-LENGTH MEASUREMENTS OF 1,050 FISH BETWEEN 105 AND 211 MILLIMETERS, STANDARD LENGTH

Item *	*Conversion factor*
T L to S L (no change in units of length)	0 7978
T L (inches) to S L (millimeters)	20 2641
S L to T L (no change in units of length)	1 2534
S L (millimeters) to T L (inches)	0 0493
F L to S L (no change in units of length)	0 8548
F L (inches) to S L (millimeters)	21 7119
S L to F L (no change in units of length)	1 1699
S L (millimeters) to F L (inches)	0 0461
T L to F L (no change in units of length)	0 9334
F L to T L (no change in units of length)	1 0714

* S L = standard length, F L = fork length, T L = total length

I- and the II-group individuals (0 07) captured at Sandusky, Ohio, in the fall The *K* (2 15) of the 0-group taken at Sandusky was relatively low

The I- and II-group fish from Erie appear to be inconsistent This inconsistency, however, is due not to the difference in age but to that in length (184 and 219 millimeters) Table X, in which the *K* values are arranged according to the length of the fish, shows that these values remain fairly constant up to a length of 192 millimeters, standard length, and then gradually increase as the fish become longer up to a length of 278 millimeters, when the values drop, although not to the level of those for the smaller fish It appears, then, that no important changes in *K* are associated with an increase in the age of the fish

An examination of the averages of *K*, comparable as to age group and season of collection, indicated that the Huron and Lorain specimens (age group I) differed by a value of 0 07 (2 39 and 2 32 respectively) and the Sandusky and Erie fish by values of 0 11 (age group I) and 0 31 (age group II) (Table V) These discrepancies are not due to the different years of collection, since the Huron and

TABLE XII

MONTHLY AVERAGES OF THE COEFFICIENT OF CONDITION (K) OF THE LAKE ERIE WHITE BASS COLLECTED IN 1927, 1928, AND 1929, GROUPED ACCORDING TO THREE INTERVALS OF AVERAGE STANDARD LENGTH AND AGE GROUPS

The numbers of the specimens employed are given in parentheses

Average standard length interval in mm	Age group	July	August	September	October	November	Average
128–171	I	2 39 (205)	2 33 (372)	2 39 (35)	2 25 (422)	2 53 (109)	2 33 (1,143)
175–188	I and II	2 33 (25)		2 46 (36)	2 42 (77)		2 41 (138)
206–233	II		2 48 (246)	2 41 (136)	2 55 (92)		2 47 (474)

Lorain materials were taken in 1929, and no important variations existed in the Erie values for the years 1928 and 1929 (Table V) The white bass captured in the eastern end of the lake had higher K values than those taken in the western areas Again, it appears that the discrepancies are associated with length rather than with localities, since the Erie fish averaged larger than those of the other ports involved

Some idea of the extent of monthly fluctuations in the value of K may be obtained from the data of Table XII The coefficients of age groups I and II have been combined for the sexes, localities, and years of collection Since it was found that length was a significant factor in the variability of K, the data of Table XII have been grouped according to the average standard length of the fish of the different collections The July individuals of the 175–188-millimeter group are I-year fish, the other specimens belong to age group II The October specimens of the 206–233-millimeter length interval averaged 13 millimeters longer than the group of the next largest fish, and this no doubt accounts for their high value of K (2 55) There does not appear to exist a consistent trend in K as the season advances, except that in November the coefficient of condition was high (2 53). The averages for each size class again

show the correlation between the value of K and the length of the fish The grand average of K based on 1,755 specimens is 2 37

VII SEX RATIO

As stated on page 315, only the 1929 materials provide adequate information on the relationships between the sexes The data on sex ratios, given in Table XIII, show an increase in the percentage of females with age, although the older fish are not well represented.

TABLE XIII

SEX RATIOS OF THE LAKE ERIE WHITE BASS COLLECTED IN 1929

Age group	Locality	Date	Total number of fish	Number of males	Number of females	Percentage of males	Percentage of females
I	Huron, Ohio	July 1	201	117	84	58	42
	Lorain, Ohio	August 14	291	146	145	50	50
	Total		492	263	229	54	46
II	Huron, Ohio	July 1	24	13	11	54	46
III	Huron, Ohio	July 1	41	9	32	22	78
IV	Huron, Ohio	July 1	2	0	2	0	100
VII	Huron, Ohio	July 1	2	0	2	0	100
I–VII			561	285	276	51	49

Among the I-group fish collected at Huron the males comprised 58 per cent of the sample, which percentage was reduced to 54 in the II-group and to 22 in the III-group No males were represented among the IV- and VII-group individuals The increasing dominance of the females with age suggests that the males are the less viable The data on sexual maturity (p 329) indicate, however, that the males mature earlier in life than do the females, and since the fishery concentrates on the spawning run (p 307), the males are removed first from the lake, which results in a shift in the sex ratio of the older fish The sex ratios may also fluctuate to some degree in the different areas of the lake or on different dates, since the percentage (50) of the I-group males was less at Lorain on August

14, 1929, than at Huron on July 1, 1929 When the data of all age groups are combined the sex ratio is approximately 50 50

VIII AGE AND SIZE AT SEXUAL MATURITY

Since the 1927 and 1929 data on sexual maturity were consistent and supplementary, they were combined for each age group and arranged in Table XIV according to total lengths All the 1927 materials were collected at Sandusky, Ohio, and all the 1929 data at Huron, Ohio, on July 1, 1929 All the 0-group white bass, which were collected in 1927, were immature Ninety-one per cent of the I-group fish were immature All the mature individuals of this group were males captured in 1927 Virtually all the I-year immature fish, 7 5 inches and larger, were also taken in this year, nearly all the smaller specimens were collected in 1929 Fifty-eight per cent (6 males, 8 females captured in 1929) of the II-group and all older individuals were sexually mature The majority of the fish (sexes combined) do not begin to develop sexually until their third summer or to spawn until the age of three years, when they average 10 9 inches in total length (Table VII) The males, however, begin to reach maturity in the second summer, a year earlier than do the females, and to spawn at two years, when they average approximately 8 2 inches in total length

The data in the column at the extreme right of Table XIV indicate that all white bass under 7 5 inches, total length, were immature Not until the fish reached the length interval 9 5–10 0 inches did the majority of a size class show developing sex organs All specimens larger than 10 inches, total length, were recorded as maturing Eighty per cent of the 452 white bass taken in trap nets were immature

The data suggest that, in order to protect adequately the majority of the white bass that have not yet spawned, a legal size limit of 11 inches, total length, must be established The present size limit is 9 inches in Ohio and Michigan Of the 88 sampled fish of legal length 20 specimens, or 23 per cent, were immature. Sixty-nine per cent of the 88 legal fish were less than 11 inches in length. An unknown number of these, although maturing, had never spawned before The available data indicate, then, that somewhere between 23 and 69 per cent of the fish taken legally in commercial impounding nets have never spawned

TABLE XIV

NUMBER AND PERCENTAGE (IN PARENTHESES) OF IMMATURE AND MATURE LAKE ERIE WHITE BASS IN THE COMBINED COLLECTIONS TAKEN AT SANDUSKY, OHIO, IN 1927 AND AT HURON, OHIO, ON JULY 1, 1929, ARRANGED ACCORDING TO AGE AND TOTAL LENGTH

Total length interval in inches *	Standard length interval in mm	Age group									
		0	I		II		III	IV	VII	0–VII	
		I†	I	M†	I	M	M	M	M	I	M
4.5–5.0	91–100	1 (100.0)	3 (100.0)	0 (0.0)						4 (100.0)	0 (0.0)
5.0–5.5	101–110		4 (100.0)	0 (0.0)						4 (100.0)	0 (0.0)
5.5–6.0	111–121	3 (100.0)	43 (100.0)	0 (0.0)						46 (100.0)	0 (0.0)
6.0–6.5	122–131		85 (100.0)	0 (0.0)						85 (100.0)	0 (0.0)
6.5–7.0	132–141		55 (100.0)	0 (0.0)						55 (100.0)	0 (0.0)
7.0–7.5	142–151		19 (100.0)	0 (0.0)						21 ‡ (100.0)	0 (0.0)
7.5–8.0	152–161		34 (94.4)	2 (5.6)	1 (100.0)	0 (0.0)				35 (94.6)	2 (5.4)
8.0–8.5	162–171		47 (97.9)	1 (2.1)	3 (100.0)	0 (0.0)				52 ‡ (98.1)	1 (1.9)
8.5–9.0	172–181		35 (63.6)	20 (36.4)	2 (66.7)	1 (33.3)				38 § (64.4)	21 (35.6)
9.0–9.5	182–192		13 (68.4)	6 (31.6)	2 (28.6)	5 (71.4)				15 (55.6)	12 § (44.4)

9.5–10.0	193–202		3 (50.0)	3 (50.0)	2 (33.3)	4 (66.7)				5 (41.7)	7 (58.3)
10.0–10.5	203–212				0 (0.0)	3 (100.0)	6 (100.0)			0 (0.0)	9 (100.0)
10.5–11.0	213–222				0 (0.0)	1 (100.0)	11 (100.0)	1 (100.0)		0 (0.0)	13 (100.0)
11.0–11.5	223–232						10 (100.0)			0 (0.0)	10 (100.0)
11.5–12.0	233–242						10 (100.0)			0 (0.0)	10 (100.0)
12.0–12.5	243–252						3 (100.0)			0 (0.0)	3 (100.0)
12.5–13.0	253–262						1 (100.0)	1 (100.0)		0 (0.0)	2 (100.0)
13.0–13.5	263–273										
13.5–14.0	274–283										
14.0–14.5	284–293								1 (100.0)	0 (0.0)	1 (100.0)
14.5–15.0	294–303								1 (100.0)	0 (0.0)	1 (100.0)
Total		4 (100.0)	341 (91.4)	32 (8.6)	10 (41.7)	14 (58.3)	41 (100.0)	2 (100.0)	2 (100.0)	360 (79.6)	92 (20.4)

* The fish included within each total-length interval had lengths equal to the lowest and up to, but not including, the greatest length of the interval

† I = Immature, M = Mature

‡ Includes two fish for which no age was determined.

§ Includes one fish for which no age was determined

IX SUMMARY

1 The study on the age and growth of the Lake Erie white bass was founded on 1,869 fish taken in 1927, 1928, and 1929 in commercial trap nets and pound nets The data on length–weight relationship were obtained from 4,904 specimens

2 The direct-proportion calculated lengths were corrected for the differential growth in length of the body and the anterior radius of the scale by the formula given on page 309 Figure 1 provides a graphic view of the body–scale relationship

3 Although all age groups from 0 to VII were represented in the samples, only 4 7 per cent of the fish were older than three years Age groups I and II dominated in the catch The 1926 year class dominated the collections made in 1927 and 1928, and the 1928 year class dominated in 1929

4 Length frequencies of all fish combined exhibited a mode at 175 millimeters (8 6 inches, total length), which corresponded with that of the I-group fish Eighty-seven per cent of the white bass varied between the 7- and 11-inch length intervals, and approximately 62 per cent of the individuals were below Ohio's legal size limit of 9 inches

5 The females were only slightly larger than the males at corresponding ages The differences did not appear to be significant

6 The season's growth was virtually completed by the middle of October

7 No differential growth existed among the white bass from different localities as the result of inhabiting various sections of the lake. With respect to growth the Lake Erie population may be considered homogeneous

8 Differential growth occurred among the year classes Both the first- and second-year growth improved progressively in the calendar years 1926–28 It is suggested that this change may possibly be associated with the great abundance of the 1926 year class — improved growth being inversely correlated with density of population

9 The greatest growth in length occurred in the first year, followed by a progressive decline through the seventh year

10. The greatest increment in weight occurred in the third year, the smallest, in the first If we are to take advantage of the rapid

growth in weight, the white bass should be protected by an 11-inch legal size limit The present size limit in Ohio and Michigan is 9 inches

11 An apparent compensation in growth occurred in the third year of life

12 An equation has been developed that expresses with considerable accuracy the length-weight relationship The curve expressing this relationship has been so drawn on the graph that lengths may be converted readily from standard to total and vice versa, and weights from grams to ounces and vice versa The length-conversion factors exhibited no significant or consistent variation with a change in the length of the fish A single factor was therefore employed for each type of conversion

13 The coefficient of condition, K, did not vary significantly with the sexes, age groups, localities, calendar years, or months of the growing season The K value rose in November, and also showed some correlation with the length of the fish The K remained fairly constant up to a length of 192 millimeters, then increased gradually up to a length of 278 millimeters, when it dropped The high average value of K (2 37) indicates that the white bass is robust in form

14 The sex ratio of all fish combined was approximately 50 50, although the percentage of females increased with age, owing primarily to the capture of the younger and earlier-maturing males

15 The majority of the white bass (sexes combined) began to spawn at the age of three years, when they averaged nearly 11 inches in total length Males began to spawn a year earlier than the females, that is, at the age of two years and an average length of 8 2 inches To provide adequate protection for the nonspawned fish, a legal size limit of 11 inches, total length, must be established (See also item 10) Between 23 and 69 per cent of the white bass taken legally in commercial impounding nets have in all probability never spawned

United States Department of the Interior
Fish and Wildlife Service
Ann Arbor, Michigan

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GEOGRAPHY

LAKE-SHORE INVENTORY AND CLASSIFICATION

NEAL M BOWERS, KENNETH C McMURRY, AND KATHERINE M STAHL

MICHIGAN'S shore line, facing four of the Great Lakes and extending over 1,600 miles,[1] is longer than that of any other water-bounded state in the Union The property along this shore is largely held in private ownership, frequently for speculation and often with the mistaken notion that all frontage has relatively high value

This paper, growing out of work done at the University of Michigan Geography Camp during the summer session of 1940, represents an effort to discover what items make up shore complexes, to arrive at a system of classification based upon these items, and to determine the extent of types derived from this classification along the shore under study It must be recognized that this report is a record of progress, covering investigation of a small area Much more work in the field will be necessary before any final classification of value to both state and private interests can be reached The strip of shore in question is located along the northwestern coast of Emmet County, between McGulpin Point and the little village of Goodhart (Fig 1), and is approximately fifty miles long

The intensive recreational usefulness of any shore is best expressed in terms of public demand Bathers want sandy beaches with sandy foreshores, wide strips of shallow water in which children can wade and splash, and deep water not too far from shore for swimming Those who sail ask for safe anchorages and wide stretches of water free from rocks and sand bars Campers need dry sites, sufficiently well drained to insure proper sanitation Accessibility is another factor to be considered The fluctuation of water levels from one year to another must also be noted in evaluating shores for such use.

[1] *Michigan Official Directory and Legislative Manual*, 1939, p 6 Michigan Department of State.

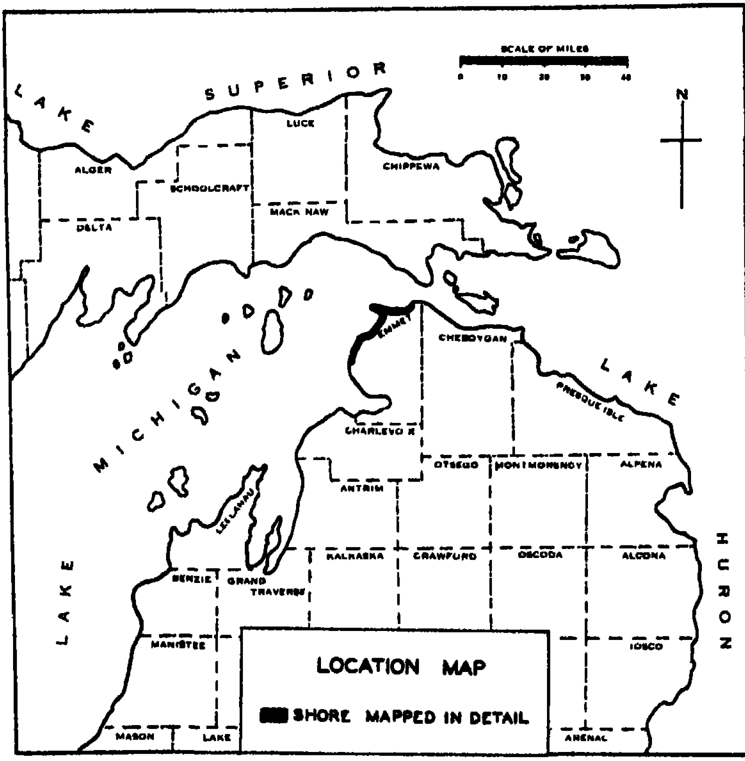

FIG 1

The character of the shore line depends upon the nature of the land and the length of time the water has been working along the shore An approach to the problem of shore classification from this point of view would give, however, a genetic system of little value in terms of shore types for recreational use In order to picture most completely the physical nature of the shore and to include the many diverse geographic, physiographic, and botanic elements the classification must be empirical

In undertaking a systematic study of shores it was necessary to adopt a definite terminology The water line was defined as the line at which the land and the water meet Landward from this line to

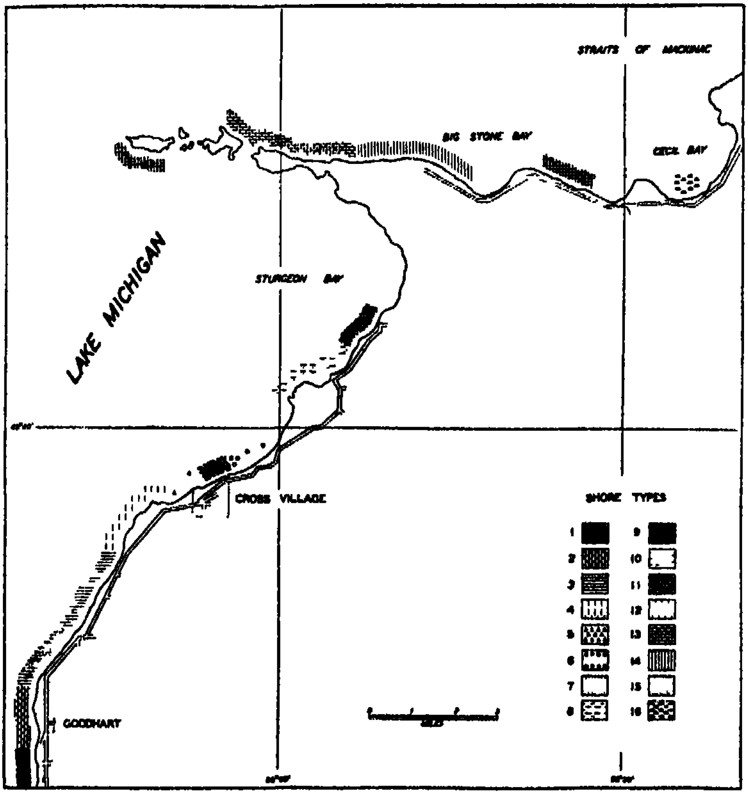

FIG 2 Shore classification

the limit reached by waves during storms is the beach, the strip over which the water washes. Still farther landward is the backshore, a zone of indeterminate width. Lakeward from the water line is the foreshore, a water-covered strip of varying width, arbitrarily marked on its outer margins by the five-foot water contour. The combination of these three elements, the backshore, the beach, and the foreshore, makes up the shore.

So many factors contribute to the suitability or the unsuitability of a shore for various recreational purposes that it was necessary to

TABLE I

LAKE MICHIGAN SHORE TYPES ALONG THE NORTHWESTERN COAST OF EMMET COUNTY, MICHIGAN

TYPE	BACKSHORE	BEACH	FORESHORE
I	Bluff, strip 3 to 8 chains wide between beach and base of bluff, covered by small sand dunes Mixed hardwood	Sand, 1 to 4 chains wide	Gravel, pebbles, cobbles, boulders, 6 to 20 chains wide
II	Bluff, strip 3 to 8 chains wide between beach and base of bluff, covered by small sand dunes Mixed hardwood and conifer on face of bluff, hardwood on top	Sand, cobbles, boulders, marsh patches, 1½ to 5 chains wide	Sand, cobbles, boulders, 5 to 10 chains wide
III	Bluff Mixed hardwood and conifer on face, hardwood on top	Sand, 1½ to 5 chains wide	Sand, cobbles, boulders, 6 to 20 chains wide
IV	Dunes, fixed Hardwood cover	Sand, 1 to 4 chains wide	Sand, cobbles, boulders, 5 to 10 chains wide
V	Bluff, strip 8 to 10 chains wide from beach to base of bluff, covered by sand ridges and small fixed dunes Hardwood cover on bluff, grass below the bluff	Sand, 1 chain wide	Sand, 5 chains wide
VI	Dunes, fixed Norway pine and white pine	Sand, pebbles, ½ to 1 chain wide	Sand, pebbles, cobbles; 3 chains wide
VII	Dunes, active dunes backed by fixed dunes Jack pine, oak, poplar	Sand, pebbles; 1 to 3 chains wide	Sand, 1 to 3 chains wide

TABLE I (*Concluded*)

Type	Backshore	Beach	Foreshore
VIII	Dunes, active dunes backed by fixed dunes, large blow-outs in the active dunes White pine, oak, poplar	Sand, 2 to 4 chains wide	Sand, cobbles, boulders; 3 to 10 chains wide
IX	Dunes, fixed Mixed hardwood, poplar, birch	Sand, gravel, pebbles, cobbles, marsh patches; 1 to 3 chains wide	Sand, cobbles, boulders, mud, marl, 4 to 10 chains wide
X	Beach ridges Conifer cover	Pavement, gravel, pebbles, cobbles, marsh patches; 2 to 18 chains wide	Sand, cobbles, boulders, 15 to 25 chains wide
XI	Beach ridges Conifer cover	Cobbles, boulders, shingle, 3 to 6 chains wide	Cobbles, boulders, bedrock, ½ to 3 chains wide
XII	Beach ridges Mixed-conifer cover	Pebbles, cobbles, boulders, 2 to 18 chains wide	Cobbles, boulders, ½ to 9 chains wide
XIII	Beach ridges Mixed-conifer cover	Sand, gravel, pebbles, 1 to 5 chains wide	Sand, gravel, pebbles, cobbles, 5 to 15 chains wide
XIV	Beach ridges Mixed-conifer cover, poplar	Sand, cobbles, boulders, marsh patches; ½ to 6 chains wide	Pebbles, cobbles, boulders, 5 to 15 chains wide
XV	Beach ridges Mixed-conifer cover	Sand, 1 to 4 chains wide	Sand, 2½ to 6 chains wide
XVI	Beach ridges Mixed-conifer cover	Marsh, 8 to 15 chains wide	Mud, sand, 10 to 15 chains wide

consider the shore features in detail. Mapping was done on a scale of eight inches to a mile, covering the backshore, the beach, and the foreshore Surface configuration, drainage, vegetation, and the nearest roads were mapped on the backshore, surface materials and vegetation on the beach, bottom materials and water depths on the foreshore The width of the beach and the distances from the

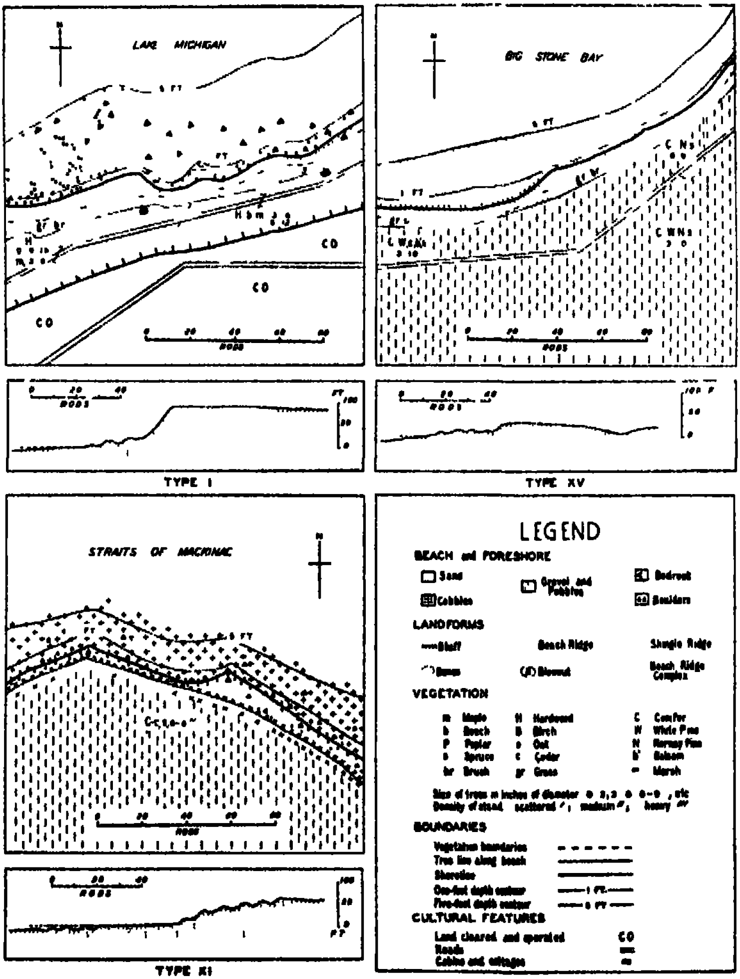

Fig 3 Shore types

water line to the one-foot and five-foot water contours were also indicated on the field sheets Note was made of any recreational development along the shore — cottages, hotels, tourist camps, and state parks

Considerable more diversity was found than was expected In general, the backshore consisted of three surface types, dunes, bluffs, and beach ridges, with cover ranging from solid hardwood stands through various mixed associations to solid conifer Along the beach and foreshore, mud, marl, sand, gravel, pebbles, shingle, cobbles, small boulders, large boulders, and bedrock occurred singly and in combination Beach vegetation was composed of grasses, brush, and marsh plants The beach varied in width from ½ chain to 18 chains, the foreshore, from ¼ chain to 25 chains

Observation in the field and study of the maps brought out varying qualities from one shore locality to another, and characteristic backshore, beach, and foreshore types were established Groupings of these three elements gave shore types which could be mapped as definite entities (Fig 2)

Sixteen different shore types were established (Table 1) These may be grouped under three broad categories on a basis of intensive recreational possibilities For example, Type XV (Fig 3), with a mixed-conifer-covered backshore of beach ridges, a sandy beach from 1 to 4 chains wide, and a sandy foreshore from 2½ to 6 chains wide, makes an ideal shore for such use In sharp contrast to this, and falling definitely under the poor class in this relation, is Type XI (Fig 3), with a backshore of conifer-covered beach ridges, a shingle, cobble, and boulder beach, 3 to 6 chains wide, and a bedrock, cobble, and boulder foreshore, ½ to 3 chains wide Midway between these two is Type I (Fig 3), with a hardwood-covered bluff backshore, a sandy beach 1 to 4 chains wide, and a foreshore of gravel, pebbles, cobbles, and boulders, 6 to 20 chains in width.

Along the shore studied only six miles, or about 12 per cent of the total frontage, may be classed as good on this basis Twenty per cent may be classified as fair, 68 per cent is definitely poor. In terms of various other uses different ratings might be developed

In final analysis it appears that, except for limited areas, the greater part of the shore is almost worthless for those recreational uses upon which high frontage values are postulated Our work here, which shows only an approach to the problem, needs much

further extension before a final conclusion can be reached The shore types developed are not to be regarded as representative of all shores A continuation of work along the coast would introduce other types, and thus increase the complexity of the system Further simplification is needed, but this must be accomplished without too great loss of detail, otherwise the value of the classification will be lost

University of Michigan

DRY-LAND WHEAT IN NORTH-WESTERN COLORADO

CHARLES M DAVIS

DURING the decade of homesteading in western Colorado from 1910 until 1920 Moffat County, in the northwestern corner of the state, came to be a dry-land wheat-producing area The relatively heavy rainfall for a plateau district, together with a direct railroad connection with Denver, permitted the homesteaders to depend upon wheat for their living rather than upon cattle ranching Under the enlarged homestead acts the wheat farmers had much more land available than they cared to plant each year The amount of this land which was put into cultivation varied tremendously from year to year, presumably in accordance with what the farmers estimated would be the returns The following statistical analysis is an attempt to explain the factors which influenced the year-to-year planting [1]

The first condition which might affect the planting of wheat acreage would seem to be price The homesteaders were primarily cash farmers, not cattle ranchers Wheat, the frontier crop, was the medium by which they could most readily realize a cash return with a minimum of capital investment From 1920, the first year for which statistics are available, until 1933 the curves of acreage and price, as illustrated by Figure 1, show a strong correlation in trajectories There is a lag of a few years between the turning points of price and acreage It is reasonable to suppose that the acreage planted in any given year was determined on the basis of the last year's price It is entirely possible that the shape of the curves represents nothing except the operations of chance

A second factor which might influence the wheat farmers would be the yields per acre from year to year Both spring and winter wheat are produced on the dry land of Moffat County. The homesteaders apparently preferred spring wheat to winter wheat, for

[1] Statistical information for the years indicated has been taken from *The Yearbook of Colorado*, published annually, with some exceptions, by state agencies.

until 1920 the acreage of the former was two or three times as great as that of the latter The deflation which marked the end of the wheat boom of 1917-19 cut the spring-wheat acreage down to equality with that of winter wheat The end of this decline is seen in Figure 1, and is again evident in Figure 2, which shows the yield and acreage of spring wheat only Since 1925 the general correlation of the curves has been fairly close, but a relationship of cause and

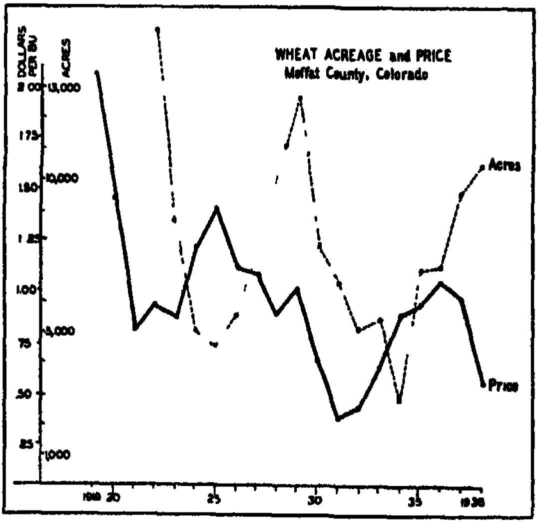

FIG 1 The acreage of all wheat follows with a comparatively constant lag the variations in the price per bushel (acreage and price figures from the *Yearbook of Colorado*, for the years shown on the graph)

effect should not be stressed in this correlation At several places the critical turning points in the curve of acreage precede the corresponding turning points in the curve of yield Though significant and prolonged periods of decreasing yields probably would discourage plantings, it is hardly plausible that a farmer could anticipate yield one or two years in advance It is more unbelievable that any cash grain producer would cut his acreage in the face of increasing yields

The curves representing the acreage and yield variations of winter wheat (Fig 3) seem to indicate that only prolonged slumps in the

yield per acre have important effects on planting The turning points in the curve of acreage quite regularly coincide with or precede the points in the curve of yield Though this gives a superficial aspect of correlation, it still remains to be shown how a farmer deciding on the amount of acreage to plant in October could have any idea, in this area of fluctuating rainfall, what might be the yield per acre of next summer's crop

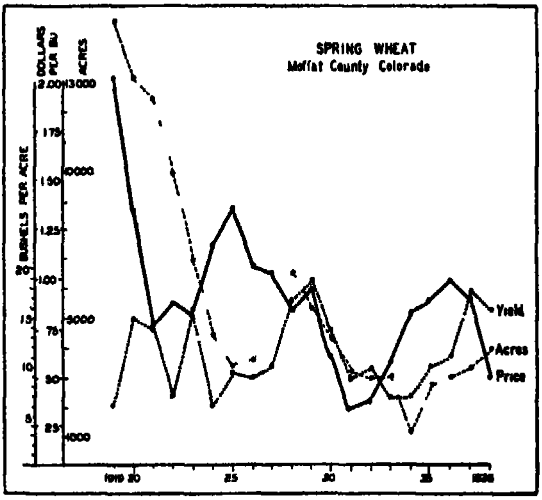

FIG 2 Until 1925 the acreage of spring wheat indicated little relationship to the yield per bushel Since that year the curves of yield and acreage have shown a close correlation

Unless the evidence presented by these fluctuating values is entirely the product of chance, one must conclude that the wheat farmer in this area varies his acreage in accordance with the price of wheat in the preceding year and not in general with yields per acre Almost any farmer can speculate concerning probable wheat prices, but as for the spring rainfall in western Colorado no man can have a very useful opinion

Though the variation in planting is a function of human opinions on the matter, the variations in yield per acre must be induced by

natural causes. The weather station at Lay, within the wheat area of Moffat County, produced reliable statistics until 1935. The cumulative rainfall figures from this station have been put together in an attempt to find a precipitation value which will fluctuate in rhythm with the yield curve of either spring or winter wheat After some experimentation it was evident that the cumulative rainfall from November until the end of April produced the curve which

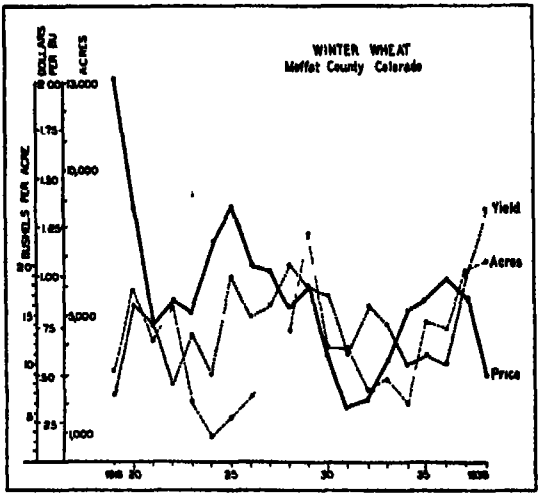

FIG 3 The general trajectories of the curves of acreage and yields of winter wheat show a relatively strong correlation throughout the statistical period The early fluctuation of acreage in terms of price, as shown in Figure 2, is not apparent with winter wheat

correlates most closely with those of either spring or winter wheat yields (Fig. 4) A conclusion might be drawn that, though spring wheat is planted much later than winter wheat, it is equally dependent upon the winter rainfall stored in the ground.

The correlation of the fluctuations of the graphs of rainfall and yield is not perfect, and other factors need to be added to explain the divergencies of the curves The rain-gauge precipitation is certainly different from the effective precipitation The factor of evaporation

as well as that of late frosting has not been taken into account The trajectories of the curves follow one another fairly well, but there are many discrepancies which need to be explained If rainfall is the sole factor, one wonders why the years with the most rain are not also the years of highest production In addition, the driest years

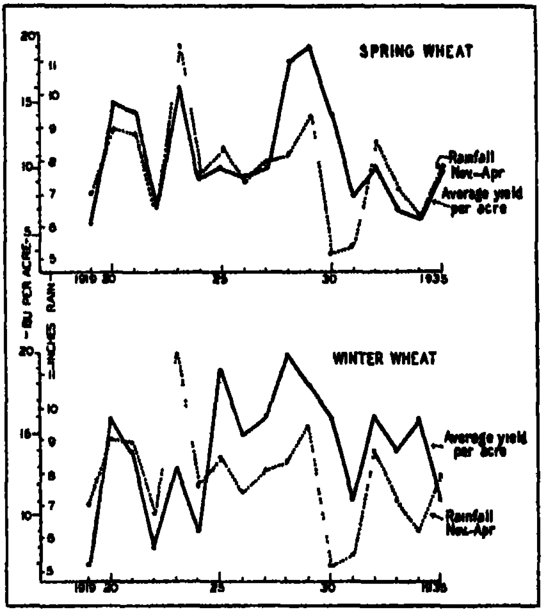

Fig 4 The yield curves of both spring and winter wheat show certain irregularities and also certain correlations with the curves of the rainfall from November to April of the crop year

have not produced the lowest yields The months in which excesses of precipitation or of drought occur seem to have considerable significance The yield in 1919 was extremely low after a total rainfall of less than two inches in the preceding November, December, and January February, March, and April brought enough rain to restore the average to an almost normal mean This combination, however, produced the poorest yields, both of spring and of winter wheat, in

the history of the Moffat County dry-farming area The rainfall low of 1930 resulted from drought in February, March, and April and made a very significant dip in the yield curve In December before the peak yield of winter wheat of 1928 the rainfall was three and one-half inches, but that for January and February combined was less than one inch The peak of spring wheat came one year later, in 1929, yet there was no appreciable difference in the May and June rainfall of these two years If the key to fluctuating yields is to be found in fluctuating rainfall, it must be sought in the monthly variations of the winter and early spring

University of Michigan

FARMSTEADS AND LAND TYPES IN EMMET COUNTY, MICHIGAN

FRED W FOSTER

INTRODUCTION

A METHOD of land classification in which the unit of inventory is the land type has been proposed and applied in the field[1] The basic land types for Emmet County were established by J O Veatch after reconnaissance in the early summer of 1937 By the close of the field season the northern two thirds of the county had been mapped[2] The work was completed during the summers of 1938 and 1939 With aërial photographs it was possible to revise and refine the land types outlined in the first summer New ones were added, and some were dropped to achieve the same degree of detail

If the land types as established are valid entities, there should be some relationship between the physical conditions they represent and the cultural patterns that develop as they are used by man Such connections will be best expressed in terms of productivity A complex of conditions in addition to the productivity of his land influences the ultimate success or failure of any farmer These include ambition, alertness, available markets, and the cost of transportation In a small area where the same general advantages and disadvantages prevail marked variations in the character of farms and farmsteads from place to place will, however, reflect the quality of the land On the basis of this idea correlations have been made between the land types and the farms and farmsteads in Emmet County

DESCRIPTION OF THE LAND TYPES (SEE FIG 1)

As Emmet County is approached from the north the land rises in a series of terraces retreating from the shore of Lake Michigan These terraces are level or slightly inclined and are marked by

[1] Veatch, J O, "The Idea of the Natural Land Type," *Proceedings of the Soil Science Society of America*, 2 499–503. 1937

[2] Sturling, M C, "Land Types in Emmet County, Michigan," *Pap Mich Acad. Sci., Arts, and Letters*, 24 (1938), Part III 55–59 1939

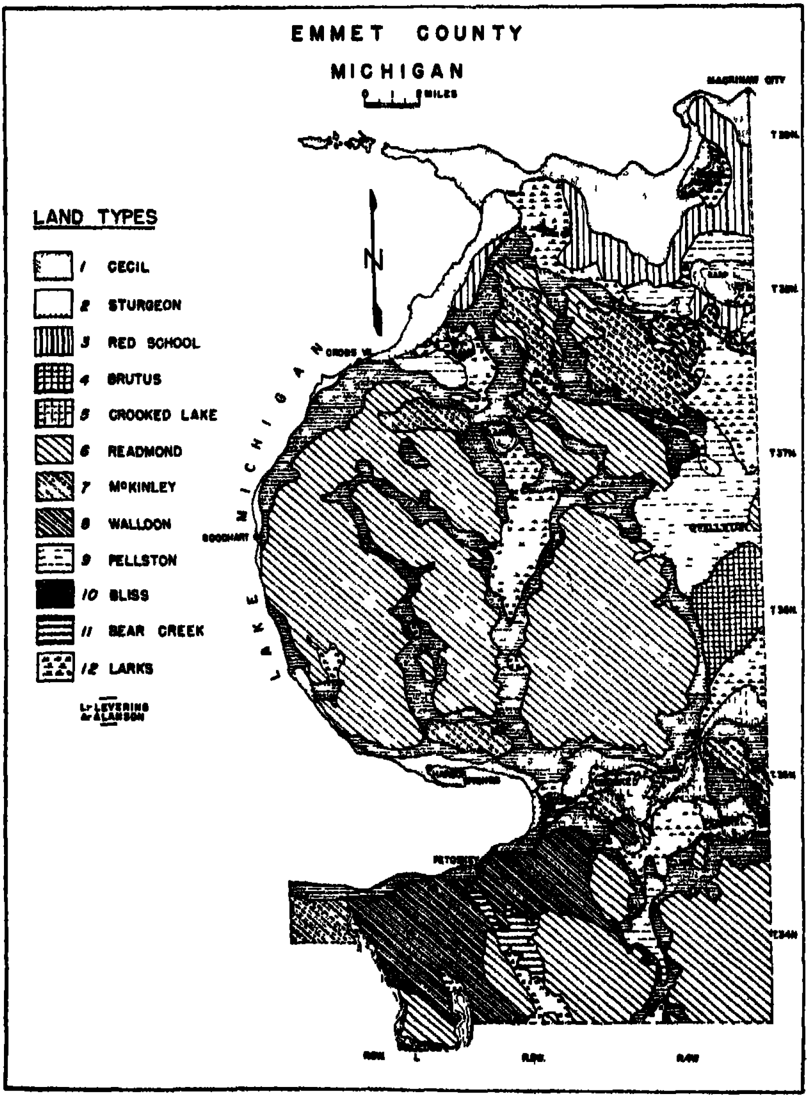
EMMET COUNTY
MICHIGAN
LAND TYPES
1 CECIL
2 STURGEON
3 RED SCHOOL
4 BRUTUS
5 CROOKED LAKE
6 READMOND
7 McKINLEY
8 WALLOON
9 PELLSTON
10 BLISS
11 BEAR CREEK
12 LARKS
LAKE MICHIGAN

FIG. 1

relict shorelines along the lakeward margins The nature of the drainage is dependent upon the position of the terrace and the character of the soil material South of the benches a morainic mass stands high above a surrounding lowland area of diverse composition The lowland is particularly evident along the east side of the county and is terraced after the manner of the benches in the north The morainic material is shaped into drumlin-like ridges or deposited as sandy plateaus that are cut by numerous dry valleys The plateau surface and its margins exhibit occasional kamic deposits A number of broad flat-floored valleys transect the moraines Their location is such that they separate the upland into a series of poorly defined ranges with a north-south trend In the southern part of the county the eastern lowland swings to meet Little Traverse Bay South of the depression thus formed the elevated area continues — the drumlins in the west and the sandy moraines in the east On the varied surface described, with its complex associations of soil, slope, vegetation, and drainage, the land types are developed

OUTLINE OF THE LAND TYPES

1 *Land Types with Small Local Relief and Slow or Poor Drainage*

CECIL

Vegetation

Major — Cedar, balsam fir, white spruce, aspen, white pine, Norway pine, red maple, alder, willow

Minor — Ash, elm, white birch, tamarack, hemlock, marsh grasses, sedges, leatherleaf bogs

Surface Successive beach ridges with occasional flat areas

Soil[3]

Major — Alpena loam and cobbly loam, Eastport sand

Minor — Newton sand, Rifle peat, Greenwood peat, Wallace sand, Saugatuck sand and Granby sand

Drainage Poor in swales and flats, small sluggish streams

RED SCHOOL

Vegetation Cedar, white spruce, balsam fir, aspen, elm, ash, red maple, yellow birch, basswood, tamarack

Surface Gently sloping toward the lake, broken by old sandy beach ridges

Soil

Major — Ogemaw sandy loam, Munuscong sandy loam

Minor — Saugatuck sand, Newton sand and Rubicon sand

Drainage Slow, water has a tendency to stand on surface

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[3] For a description and discussion of the soils mentioned see Foster, Z C, Shearin, A E, Millar, C E, Veatch, J O, Donahue, R L, *Soil Survey of Cheboygan County, Michigan.* United States Department of Agriculture, Series 1934, No 15 1-47 1939

CROOKED LAKE
Vegetation Cedar, white spruce, tamarack, elm, ash, red maple, aspen
Surface Level, gently sloping
Soil
Major — Bergland clay loam or loam
Minor — Newton sand, Granby sand, or Rifle peat
Drainage Slow on surface, ground water table high

BEAR CREEK
Vegetation Aspen, with some conifer and red maple
Surface Level to gently sloping with occasional sandy ridges
Soil
Major — Antrim sandy loam
Minor — Kalkaska sandy loam, Newton sand and Saugatuck sand
Drainage Slow to poor

BRUTUS
Vegetation
Major — Red maple, elm, aspen, ash
Minor — Cedar, spruce, balsam fir, hemlock
Surface Level, gently rolling
Soil
Major — Selkirk silt loam, Brimley fine sandy loam
Minor — Ogemaw sandy loam, Saugatuck sand, Newton sand, Rubicon sand
Drainage Slow to poor, seepage on some slopes

LARKS
Vegetation Cedar, white spruce, balsam fir, ash, elm, red maple, alder, willow, aspen, tamarack, balm of Gilead, white and yellow birch
Surface Flat
Soil
Major — Rifle peat, Newton sand, Saugatuck sand
Minor — Granby sand Greenwood peat, Bergland clay loam
Drainage Poor

2 *Land Types with Small Relief and Rapid Drainage*

BLISS
Vegetation
Major — Hard maple, beech, elm
Minor — Pin cherry, hemlock, aspen, basswood, yellow birch, white birch, white pine, Norway pine
Surface Gently sloping, sometimes sharply broken at intervals, where terraces develop
Soil
Major — Kalkaska loamy sand or sandy loam
Minor — Rubicon sand, Wallace sand, Alpena cobbly loam
Drainage Good; poor in spots

PELLSTON
Vegetation
Major — Aspen, pin cherry
Minor — Residual white or Norway pine and hard maple, bracken and grass
Surface Practically level, occasionally broken by beach ridges

Soil

Major - Rubicon sand

Minor Kalkaska loamy sand, Saugatuck sand, Wallace sand, Greenwood peat

Drainage Good, poor in occasional small areas

3 *Land Types with Considerable Local Relief*

WALLOON

Vegetation

Major — Hard maple, beech elm, basswood, yellow birch

Minor — Aspen, cherry, with cedar, balsam fir, red maple, ash, alder, and willow in depressions

Surface Pronounced drumlin-like topography with a northwest–southeast trend, steep marginal slopes

Soil

Major — Onaway sandy loam

Minor — Onaway loam, Emmet sandy loam, Granby sand, Newton sand, Lupton muck, Rifle peat

Drainage Poor in depressions

MCKINLEY

Vegetation

Major — Hard maple, beech

Minor — Basswood aspen, yellow birch pin cherry, with cedar, balsam fir, elm, ash, red maple, alder, and willow in depressions

Surface Plateau-like, or suggestive of drumlins

Soil

Major — Emmet sandy loam

Minor — Onaway sandy loam, Emmet loamy sand, Newton sand and Granby sand, Rifle peat

Drainage Poor between many of the ridges

READMOND

Vegetation

Major — Hard maple, beech, elm

Minor — Aspen hemlock, white pine

Surface Dissected sandy moraine, steep marginal slopes, gentler interior slopes, surface often traversed by a maze of "fossil" valleys

Soil

Major — Emmet loamy sand

Minor — Emmet sandy loam, Onaway sandy loam, Kalkaska loamy sand

Drainage Rapid, few streams, few if any swamp areas, some seepage on slopes

STURGEON

Vegetation

Major — Norway pine, white pine jack pine, oak, aspen

Minor — Pin cherry, sugar plum, hard maple, white birch, grass, bracken, ground juniper, swales covered with sedges and marsh grasses

Surface Dune topography with some fresh blow

Soil

Major — Wallace sand

Minor — Bridgman sand, Houghton muck

Drainage Good, poor between dunes

FARMS AND THE LAND TYPE

Indians were the first agriculturalists in Emmet County Their fields were small and widely separated, nevertheless, some corn was available for sale at the settlements along the Straits of Mackinac The government surveyors' notes record the occasional Indian clearings on the lines of traverse Unverified reports have mentioned Indian orchards But despite encouragement by missionaries and the government, agriculture seems never to have supplied all the food needed Hunting, fishing, and the gathering of wild plants supplemented the food supply The area under cultivation was expanded as white settlers encroached upon the aboriginal domain, but the fields were never far from Lake Michigan A good location was more important than soil fertility, and water travel was the chief means of communication In consequence, the lake-border land types with good drainage were spotted with Indian clearings along the shoreward margins These land types are the Bliss, Readmond, and Walloon

It is sometimes assumed that lumbering preceded agriculture over most of the northern part of the Lower Peninsula of Michigan In Emmet County lumbering and farming were contemporaneous While the woodsmen cut over the Cecil, the Red School, the Sturgeon, and the Pellston land types, and parts of the Bliss, farm clearing was going ahead rapidly in other areas The settler was not concerned with the potential value of the wood Logs were used for cabins and barn timbers The remaining trees were cut, hauled into piles, and burned

From the very beginning the newcomers tilled the soil Farm economy was based upon the production of potatoes and other root crops, grains, hay, and cattle It is interesting to note that the early settlers predicted the decline of agriculture as the "rash" among them mortgaged their land and drove their oxen to Antrim County, where they traded them for horses

These farmers labored under circumstances that were favorable to at least temporary success The towns of Petoskey and Harbor Springs were growing rapidly, boats were continually docking along the shore, and the lumber industry was in full swing Here was an adequate market for excess production Then, too, with settlement came the resort industry and the railroad One supplied a market

that would permit of some specialization, and the other an outlet for surplus produce — not ordinarily found in pioneer areas.

Much of the land gave every indication of being extremely fertile. The yields were large. Father Weikamp's mission farm, which was not considered of especially good soil, is supposed to have furnished as a twenty-year average the following per-acre harvest: wheat, 30 bushels, oats, 60 bushels, rye, 27 bushels, barley, 26 bushels, potatoes, 400 bushels, beets, 400 bushels, carrots, 400 bushels, turnips, 500 bushels, rutabagas, 500 bushels, timothy hay, 2½ tons. The soils were rich in partly decayed organic matter, and certain amounts of accumulated soluble minerals were present. Surrounding woods held few pests, either plant or animal, to interfere with production. Prospects for agricultural development were regarded as being among the best in Michigan, and there can be no question but that farming had an auspicious start.

In the sixty-five years since the first agricultural settlement development has not progressed with the same speed or to the same degree on all the land types. Though the term "general farming" might be applied to all such activity within the county, the quality and the character of the agriculture vary from land type to land type.

Walloon agriculture. — Farming on the Walloon land type is the most successful in the county. The appearance of the farmsteads is generally prosperous. Fields, fences, yards, and orchards give an impression of being well cared for. Crops are vigorous, and the signs of a successful economy are seen everywhere.

A greater part of the surface has been cleared of vegetation. Trees grow in the steep-sided valleys that occasionally cut back into the hills and along the bottoms of the poorly drained depressions. Portions of the lowland areas have been cleared and are used for pasture. Fields are large, and the fence lines are straight. Farm economy is based upon the production of potatoes and animal products. Some acreage is devoted to alfalfa and other hay crops, as well as to corn and small grains, particularly oats and wheat. A fair percentage of the cropland is in pasture.

Despite the fact that farming here is general in character three types of specialization have developed — dairying, potato raising, and flower growing. Dairy farming, common over the land type, is most prevalent in the vicinity of Petoskey. These farms are among

the best in the county Other farmers raise quantities of potatoes The extreme specialization is indicated by emphasis on the production of certified seed A few agriculturalists concentrate on flowers, bulbs, and seeds The flowers are sold in the resort market and in Chicago Seeds and bulbs are disposed of through the various seed firms

McKinley agriculture —Farming on the McKinley land type is similar to that on the Walloon Less of the surface is cleared of its forest vegetation Fields are smaller, and field lines are more irregular Use of the lowlands for pasture obtains here also There is relatively more potato raising but less dairying Alfalfa is not so important as a hay crop, although a larger share of the area is given over to hay and pasture

Readmond agriculture —Agriculture on the Readmond is not particularly prosperous There are a few areas where a greater concentration of the heavier soils is reflected in the quality of the farms, notably east and south of Goodhart and northwest of Harbor Springs Here the agriculture is almost on a par with that of the McKinley Otherwise the farms are definitely inferior in quality

The farming is confined to plateau-like areas Slopes give indications of having been used in the past, but they are mostly abandoned today A great many of the fields are unfenced or surrounded with barbed wire They vary in size and shape, and it is a common practice to crop only a part of each enclosed unit As fields are given over to hay or pasture, the bottoms of the numerous valleys may continue in crop production Parts of the farm area remain in second growth, with irregular borders marking the boundary between forest and clearing

Land use shows little diversification Corn is raised in small quantities Potatoes seem to grow better than any other crop Wheat, oats, and buckwheat are the chief small grains, but the per-acre output of none of these crops is great Most of the farm area is given over to hay and pasture Natural hay, sweet clover, and alfalfa are important in the order named The pasture land is often permanent in the sense that it may not be cropped for several years Cattle are a part of every farm system Adjoining abandoned farms are occasionally used for hay or pasture The humus content of the soil has been diminished through steady use Rapid drainage lowers the quality of the food crops, stunts the hay, and diminishes the amount of pasturage

Bliss agriculture — Agriculture on the Bliss is favored by the level surface Gravelly areas are apparently more fertile than those of a sandier texture, and the successful farms are generally on this phase of the Kalkaska soil type With the exception of two areas farming is about on a par with that of the Readmond Through the efforts of George Gibes, a Polish immigrant, a great many Poles settled on the Bliss land type in the vicinity of Larks Lake Here the farms are distinguished by the neat appearance of the buildings, the diversity of the agriculture, and the ubiquitous geese North of Harbor Springs the fortunate association of farm with city has aided the development of a successful economy Dairies occur as the resort development and the demands of the village justify their existence Near the town a number of people concentrate on the raising of fruits, vegetables, and flowers

Throughout the rest of the land type agriculture is little advanced beyond that of the Readmond Production of hay and pasture is the common use of the land Corn and potatoes are apparently better crops here Fields are more regular, but are no better fenced One factor that gives this land type an advantage over the Readmond is its flatness of surface

Brutus agriculture — Most of the Brutus land type is occupied by a religious sect — the Mennonites Under a system based on self-discipline an agricultural economy was developed that benefited all A prosperous farm community resulted Today the old manner of living is giving way before the automobile age and the principles of self-gain Though the area is still successful the evidences of agricultural decay are everywhere apparent

A heavy clay soil, the chief soil component of the land type, is difficult to plow Great power is needed to turn the furrow to any depth This feature and the resultant slow drainage make it poor land for corn, which has always been stunted, with small ears Potatoes are a fair crop, but most of the cleared land is given over to grains and hay, particularly alfalfa Fields are large, and little of the farm area is left in forest

Pellston agriculture — There are few farms on the Pellston land type They appear to function below the level of subsistence Stump pasture and natural hay predominate The lack of fences and the neglected fields make it difficult to distinguish the used land from the unused Browse lines in the small aspen groves em-

phasize the paucity of good grazing Crops seldom seem worth harvesting

Red School agriculture — Large parts of the Red School land type are not used for agriculture The area under cultivation appears, however, to be expanding Here and there fields are being cleared of stumps A stony surface and slow drainage contribute to the difficulties of farming Though farmsteads are not prosperous-looking, continual improvement has been noted over a period of three years The local markets at Mackinaw City and Mackinac Island may appreciably encourage the expansion of the farm area and the improvement of the farms

Crooked Lake agriculture — The Crooked Lake land type is handicapped by slow drainage Land is cropped, but the farm homes are for the most part abandoned Production is supplementary to that of the occupied farms on the neighboring land types Hay is the chief crop, with a minor yield of small grains Barns are large, and fences are uncommon This land type is apparently unable to support a well-rounded farm economy, but it is unlikely that it will be abandoned so long as the contiguous areas are occupied

Larks agriculture — At various places within the Larks land type surface irregularities have resulted in exposures of mineral soil These locations may be utilized for crops There are seldom more than two or three farms in any one place. The cultivated areas are irregular and are devoted to general farming Some farms leave one with the impression that the owners are not entirely dependent upon agriculture for their income

Bear Creek agriculture — Much of the cropland in the Bear Creek land type is held in farms located in large part outside the area The farms wholly on this land type are small and ill fitted for agriculture Hay and pasture constitute the chief use of the land There is little indication that it will ever be more intensively used than it is today

Sturgeon and Cecil agriculture — The Sturgeon and the Cecil land types have practically no agricultural settlement Apparently farming has never been attempted on the Sturgeon On the Cecil it was maintained to supply lumber-camp horses with hay It exists today on a subsistence or part-time basis

Certain conditions have developed in the county that are both favorable and unfavorable to the success of agriculture It is diffi-

cult to view each situation in terms of its direct relationship to a land type, nevertheless, correlations can be suggested

Part-time farmers are found throughout the county Many activities in addition to farming claim their attention from season to season Exploitation of the second-growth forest is one source of outside income The cement plant, the highway department, the seasonal demands of the resort areas are all sources of employment Many people work in the factory cities of the southern part of the state during the winter months It can be assumed that the amount of part-time farming decreases as the land type under consideration is more productive

Many farms are developed with money obtained from other sources Frequently the funds derived from the sale of the farm timber were used to build the house and barn and supply other improvements Some farms are maintained as a hobby or a place of retiral should business fail or industrial production close down The buildings and improvements on such farms often fail to reflect the agricultural productivity of the areas where they are located

In the vicinity of Harbor Springs and Petoskey and, to a lesser extent, throughout the county, the resort trade has increased farm income The purely seasonal character of this business makes it difficult, however, to adjust supply to demand If sales throughout the year could be maintained near the summer level, farmers in the county would have few financial problems

There has been some change in the method of farming during the last few years Small grains are giving way to corn At the same time the number of silos has increased Dairying is becoming more important every year In 1939 every farm in the county had, on an average, seven cows of milking age A great deal of stress is laid on the growing of potatoes for certified seed In 1939 approximately 3,400 acres were in potatoes

FARMSTEADS AND LAND TYPES (SEE FIGS 1–2)

It was felt that the number of occupied dwellings and the comparative quality of the farm buildings and farmyard units might indicate to some degree the success of agricultural enterprise in each of the land types It is not enough to say how many operating farms occur per unit of land. Analysis must go further Are the farmers barely able to supply the needs of home and family, or is

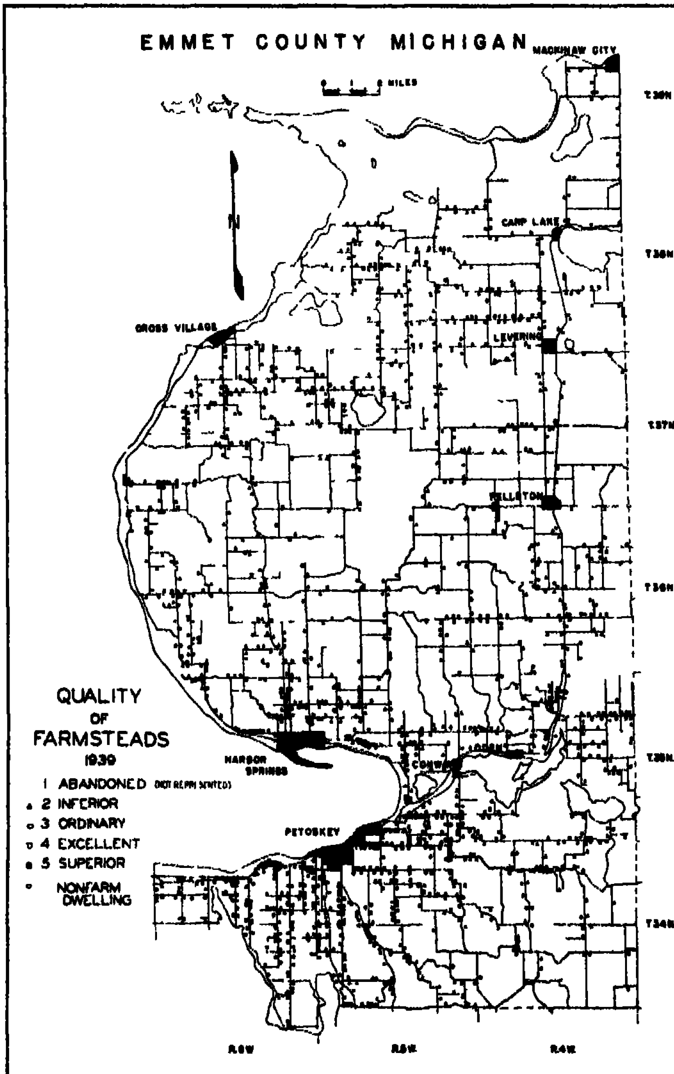
EMMET COUNTY MICHIGAN
MACKINAW CITY
MILES
T39N
T38N
T37N
T36N
T35N
T34N
CAMP LAKE
CROSS VILLAGE
LEVERING
HARBOR SPRINGS
PETOSKEY
QUALITY OF FARMSTEADS 1939
1 ABANDONED
2 INFERIOR
3 ORDINARY
4 EXCELLENT
5 SUPERIOR
NONFARM DWELLING
R6W
R5W
R4W

FIG. 2

there a surplus available to be used for the improvement of farm and buildings? Without doubt, personality and circumstance enter the picture, but it can be safely assumed that all the poor families were not concentrated on the poor land types from the very beginning. Consequently, a classification of all the rural dwellings in the county was made. The system used was a modification of the ideas presented in a bulletin published by the Cornell University Agricultural Experiment Station.[4] Occupied rural farmsteads were estimated on the basis of their quality. Nonfarm dwellings were classified at the same time. The evaluation of farmsteads was carried on without reference to the land types. Five classes of farmsteads were established. Class 1, abandoned farmsteads, will be discussed in a later paper. The other four classes are:

Class 2. — Farmsteads of inferior quality. Such farmsteads might be regarded as barely holding their own, or else they are clearly in the process of deterioration. Buildings are generally unpainted and roofs are in poor condition. Dilapidation of one sort or another prevails everywhere. There is usually little or no attempt to make the surroundings presentable. Dwellings are often log cabins or tar-paper-covered shacks. These farmsteads have either degenerated from a higher classification or never have been sustaining. (See Pl. I, Figs. 1-2.)

Class 3. — Average or ordinary farmsteads. There is a general air of moderate success. All the buildings may not be in the best condition, but a definite effort is made to keep things in good repair. Paint is not necessarily new, though painting is done periodically. Roofs are usually well cared for, and gates and fences are in good order. (See Pl. I, Figs. 3-4.)

Class 4. — Farmsteads distinctly above the average. Buildings are well roofed and painted. Yards are in good condition. Fences are in first-class shape. The appearance of the farmstead indicates that there is a more or less continual expenditure of time and money on improvements. Surplus money beyond that required for the ordinary demands of living must be available to support an establishment of this sort. (See Pl. I, Figs. 5-6.)

[4] Tyler, H. S., *An Economic Study of Land Utilization in Chenango County, New York.* Cornell University Agricultural Experiment Station, Bulletin 654. Ithaca, New York, 1936.

Class 5 — Farmsteads clearly of superior quality House, barn, and outbuildings are in optimum condition The grounds are usually landscaped A tone of prosperity prevails There are very few farmsteads of this type (See Pl II, Figs 1-2)

Nonfarm dwellings — Dwellings whose owners receive only a small part of their livelihood from tilling the soil (See Pl II, Figs 3-4)

Since the first widespread attempt at settlement agriculture has had ample time and opportunity to establish itself in all parts of the county The possibilities of crop production have been determined primarily by trial and error Failure and circumstance have eliminated many who attempted to till the soil Today the density of functional farmsteads on a land type is, in some measure, indicative of the ability of the area to support agriculture (Fig 2) The smaller the average amount of land per farmstead, the greater is the relative productivity (see Table I)

If the land types with small local relief and slow or poor drainage are considered, a marked difference in farmstead density is noted (Table I) The Cecil type, with 11 94 square miles for each farm home, stands lowest The Larks is next, with all its farmsteads on the higher ground included within the complex The Crooked Lake is third Here a considerable part of the surface has been cleared, but a well-rounded farm program is apparently impossible The Red School is fourth This relationship may be expected to change in the near future since the process of clearing is still under way Within the Brutus area, which is fifth in density, farmsteads are concentrated on the heavier soils The sandy portions are, for the most part, uncleared or abandoned The Bear Creek region is so small that the figure indicating the average area for each farm unit may not be reliable

Two land types have been characterized as having "small relief and rapid drainage" The density relationship is obvious a more fertile soil and better moisture conditions on the Bliss contribute to the greater concentration. The Pellston is relatively unattractive

The Walloon, the McKinley, the Readmond, and the Sturgeon are the land types with considerable local relief The Walloon has the smallest average area per farmstead of any type in the county Greater dissemination of farms definitely sets the McKinley apart

TABLE I

CORRELATION OF LAND TYPES AND FARMSTEAD TYPES

In the first four columns the second figure is the percentage

	Land type	Farmstead type*				Total number of occupied farmsteads	Total number of non-farms	Number of square miles in each land type	Average number of square miles per occupied farmstead
		Class 2 — inferior	Class 3 — ordinary	Class 4 — excellent	Class 5 — superior				
1	Cecil	2 100	0 0	0 0	0 0	2	1	23 89	11 94
2	Sturgeon	0 0	0 0	0 0	0 0	0	0	8 07	0
3	Red School	24 61 6	14 36	0 0	1 2 5	39	8	18 48	0 473
4	Brutus	9 37 5	12 50	2 8 3	1 4 2	24	2	8 45	0 352
5	Crooked Lake	4 44 4	3 33 4	1 11 1	1 11 1	9	2	7 10	0 779
6	Readmond	185 56 4	123 37 5	18 5 49	2 0 61	328	57	169 16	0 516
7	McKinley	69 40 3	82 47 9	20 11 7	0 0	171	15	34 74	0 203
8	Walloon	52 21 5	146 60 3	38 15 7	6 2 48	242	35	29 68	0 123
9	Pellston	15 83	3 17	0 0	0 0	18	7	20 44	1 13
10	Bliss	165 50 3	142 43 3	18 5 4	3 0 91	328	135	96 21	0 293
11	Bear Creek	7 70	1 10	2 20	0 0	10	11	2 98	0 298
12	Larks	18 69 3	7 26 9	1 3 8	0 0	26	7	46 01	1 77

* Class 1 (abandoned farms) will be discussed in a later paper

from the Walloon, even though they are similar in appearance Sandy soil, poor moisture conditions, and excessive slope have discouraged agriculture on the Readmond The average area for each

farm unit is large It is not possible to present the figures here, but this land type is characterized also by a great amount of abandonment On the Sturgeon, as has been said, agriculture has never been attempted

There are a number of factors that may act to reduce the reliability of comparisons made between the different land types on the basis of average area per farmstead For instance, on the sandier soils larger surface units are necessary to permit a balanced agricultural economy Furthermore, the scattered ridges within the Larks offer the only farm sites there For the Pellston one site is as suitable as any other The comparisons might have been more critical if they could have been made according to the amount of cleared land rather than according to total areas

Within each class the farmstead density varies considerably from land type to land type Reference to Table I will show that this same separation prevails when all the land types are considered together

The small number of Class 5 farmsteads is of no great value for correlation At least four of the fourteen listed as superior are supported by funds derived from outside sources Many of the others are dairy farms Money is available for maintenance and improvements partly as the result of location near a favorable market Nevertheless, the six of this class on the Walloon indicate a high standard of farming

Classes 2, 3, and 4 offer the best opportunity for evaluating productivity as it is reflected in farmstead quality The Walloon, with 15 7 per cent of the units in Class 4, 60 3 per cent in Class 3, and 21 5 per cent in Class 2, is obviously the best land type for agricultural use The McKinley has the next highest rating and is followed by the Brutus

There is some question whether the Crooked Lake or the Bliss should come next in this classification A greater number of functioning enterprises on the latter, however, gives it priority After the Crooked Lake, the Readmond, the Bear Creek, the Red School, and the Larks follow It is to be noted that the order is not valid in terms of any one class The positions are determined rather by a joint consideration of the three classes for each of the land types named It is doubtful whether the Bear Creek should precede the Red School

There can be little question of the relative position of the last three The Pellston, with 83 per cent of its farmsteads in Class 2, the Cecil, with two farmsteads in Class 2, and the Sturgeon, with no rural habitations, complete the sequence

A major percentage of the nonfarm dwellings are distributed without reference to the quality of the land types They are, in a sense, suburban homes built in the vicinity of Petoskey, Harbor Springs, or a place of employment It is probable that the Bliss, the Readmond, the McKinley, the Walloon, and the Bear Creek areas may on occasion offer more suitable building sites Otherwise the location is fortuitous

Many of the nonfarm residents exploit the second-growth timber Some of the best areas for cutting are found on the Bliss and the Readmond or in the poorly drained land types close at hand Distribution of such exploitation is controlled by the lack of conditions favorable to farming

CONCLUSION

Land types have been established with reference only to their physical characteristics If we make allowances for the personal attributes of ambition, superior training, and home background, and if we discount the advantages that accrue from superior location with respect to market and transportation, then we may expect that the quality and number of farmsteads and the general character of farming will reflect, in some degree, the productive quality of the land type Such a relationship is well expressed in Emmet County, where no area is at a marked disadvantage with respect to transportation and national markets It is felt that the analysis of farming, the figures and discussion pertaining to the density of farmsteads, and the correlation between farmstead quality and the land types have indicated the connections that exist A more detailed investigation would probably reveal closer relationships

MICHIGAN STATE COLLEGE
EAST LANSING, MICHIGAN

PLATES I–II

FIG 1

FIG. 2

Class 2 farmsteads Note the tar-papered house

FIG 3

FIG 4

Class 3 farmsteads That shown in Figure 3 barely falls within this group

FIG 5

FIG 6

Class 4 farmsteads

FIG 1

FIG 2

Class 5 farmsteads, on the Walloon land type

FIG 3 A nonfarm residence

FIG 4 An inferior nonfarm residence

GEOPOLITICAL STRUCTURES IN LATIN AMERICA

PRESTON E JAMES

A STUDY of the distribution of people in Latin America brings to light certain curious relationships between the population pattern and the pattern of politically organized areas Each political area, or state, has certain differentiated parts, such as nuclear concentrations of settlement, outlying areas of settlement, borders and border zones, and other distinct elements, which combine to form the internal pattern of the state This is what North American political geographers call "geopolitical structure"[1] — the arrangement of the integral parts of a politically organized area The study of these matters in Latin America has been made only superficially, yet one might assume that the fundamental problems of establishing coherent and orderly states among elements of population which are so strongly discordant would be reflected in the internal arrangement of political areas Such a reflection is, in fact, clearly to be observed, especially in those five countries — Mexico, Guatemala, Ecuador, Peru, and Bolivia — which are today occupied by a population that is more than half Indian

SIMPLE RELATIONS BETWEEN POPULATION AND POLITICAL AREA

In most parts of Latin America where the native peoples were not established in concentrated settlement before the arrival of the Europeans the present geopolitical structures are simple and elementary Certain of the Latin-American nations are composed of only one central core of dense settlement, without even one other outlying region of settlement This is the pattern to be observed in Chile, in Paraguay, in Uruguay, and in El Salvador In Chile the subdivisions of the nation are so unimportant in terms of local administration that the boundaries can easily be shifted for the purpose of securing advantages in the national elections In the last

[1] Whittlesey, Derwent, *The Earth and the State* (New York, 1939)

fifteen years they have been changed so frequently that the Chileans themselves scarcely know in what province they live

Most of the Latin-American countries, however, are composed of more than one nucleus of concentrated settlement Brazil, for instance, has twelve such nucleuses The major political subdivisions of Brazil are generally organized around one of these areas of

Fig 1

concentrated settlement (Fig 1), and the state borders are ordinarily drawn through the thinly populated country between the clusters of people The exceptions are in the southeast and in the northeast, in both of which regions the original nucleuses of settlement in each state were once separate, but have now expanded and filled the intervening areas

The relation of the clusters of people and the larger political subdivisions — the departments — of Colombia is especially clear

FIG 2

(Fig 2) There are fifteen departments in Colombia and fourteen chief areas of settlement Only two of the departments are occupied by more than one cluster of people, and only one of the clusters spreads across departmental borders. The area of concentrated settlement which crosses a border is in the Antioquia region, where the former single department of Antioquia has been divided into

two the southern part now being known as Caldas Otherwise the relationship between population pattern and political area is simple

SUPERIMPOSED BOUNDARIES IN LATIN AMERICA

Illustrations of the kind of geopolitical structure described above can be found in all parts of Latin America — from northern Mexico to Patagonia This is one of the prevailing characteristics of the twenty states to the south of the United States But there are certain exceptions, where political boundaries are drawn through the midst of densely populated areas and where political areas are made up of the separate parts of different zones of concentrated settlement These exceptional areas must not be confused with the places where population expansion has led to the formation of zones of dense settlement on either side of a boundary after the establishment of the boundary — as in parts of Brazil In the areas we are about to describe the boundaries were drawn after the present population patterns were already in existence

There are three places in Latin America where international boundaries of this sort can be observed They are all in the Andean countries of South America between Colombia and Venezuela, between Colombia and Ecuador, and in the Titicaca basin, between Peru and Bolivia[2] The description of one of these areas — the border between Colombia and Ecuador — will suffice to illustrate the processes which have been operating

The Establishment of the Colombia-Ecuador Border

The boundary between Colombia and Ecuador in the highlands passes through the center of the basin of Tulcán, an area of relatively dense Indian settlement Actually this boundary is found to be superimposed That is, the pattern of population was already established by the Indians before the arrival of the Europeans, but this Indian group was disregarded when questions of national territory were being discussed The Indian communities were not attached to the central nucleuses of the new states by the process of accretion, on the contrary, the Spanish colonists developed their own pattern of settlement, drew their own boundaries, developed their own concepts of nationality, while the Indians were treated essentially as if they were a part of the physical environment, a part

[2] James, P E, *Latin America A Human Geography* (New York, 1941).

of the land Two cultures have been occupying the land together for four centuries, without any signs of effective blending

When Bolívar's Greater Colombia began to break up after freedom from Spain had been established, the sentiment for local autonomy which led to revolt and separation was fostered by the Europeans and the strongly Europeanized mestizos, not by the people of the Indian communities Nationalism and national boundaries are concepts which were beyond the range of Indian experience The sentiment for political independence was strongest in the central nucleuses in Bogotá and Quito The position of the dividing line, which separated the territory adhering to Bogotá from the territory adhering to Quito, was determined more by conditions in the political centers than by the local arrangements along the border The southern part of what is now Colombia, which had originally been colonized by Europeans from Quito, might well have become a part of Ecuador had not a revolt in the Ecuadorean capital given the armies from Bogotá the advantage at a critical moment, which they accepted by pushing southward into territory formerly administered from the rival center

When it came to agreeing upon a line of demarcation between Colombian and Ecuadorean territory, the easiest natural feature to select, in the absence of good maps, was a river There seemed to be no need to insist on keeping a community of Indians wholly within one country or another Although there is a scantily occupied mountain ridge just south of Tulcán, this natural feature was neglected To divide a community of Europeans in such a manner would have led to many complications, but to the Indians of the basin of Tulcán, the matter remains of small importance The local inhabitants pass freely across the line, scarcely comprehending that their blood brothers on the other side are somehow different from themselves The boundary was superimposed on the Indian community by the people of another culture, the two modern states of Colombia and Ecuador were built by a colonization which simply disregarded the arrangement of people in the scantily colonized, but already densely settled, border zones

The Provinces of Central Peru

A similar process accounts for certain of the geopolitical structures of the major political subdivisions of central Peru The two

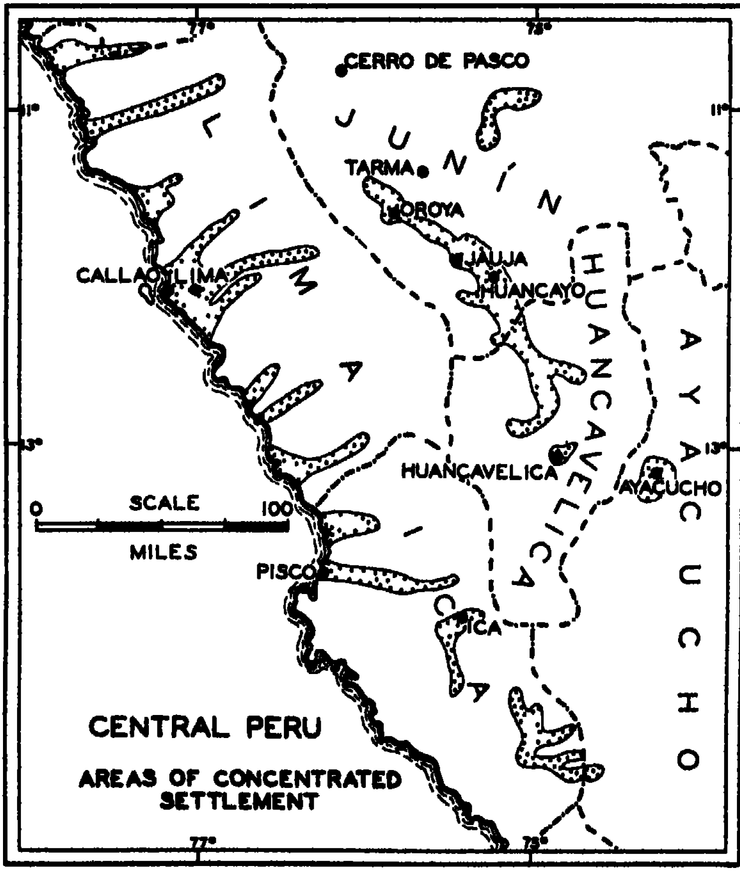

FIG 3

provinces of Junín and Huancavelica (Fig 3) divide the area of dense Indian settlement centering on Jauja and Huancayo The two provinces were not originally one, now separated because of the spread of settlement, as is true of Antioquia and Caldas The Indian settlement around Jauja and Huancayo was long established when the Spaniards first arrived on the scene But the Spaniards were interested in mining, and the chief Spanish towns were located near the mines Cerro de Pasco was a great silver-producing community,

and Huancavelica was one of the chief sources of mercury, which was of importance in the process of silver and gold mining throughout Spanish colonial America The political divisions of the Spaniards were organized around the foci of Spanish colonization — that the boundary happened to cut through the center of Indian concentration was a small matter

The States of the Central Area of Mexico

A similar situation can be observed in the relationships between state borders and population centers in the central area of Mexico (Fig 4) The state of Jalisco, to be sure, has a simple geopolitical structure, formed around a nucleus of concentrated settlement focus-

Fig 4

ing on Guadalajara But the other states between Jalisco and Veracruz show a notable lack of harmony with the pattern of people

The origin of this confusion seems to be similar tô that suggested for central Peru The political subdivisions of Mexico — the states — were delimited on the basis of the colonial administrative areas, organized around the centers of Spanish settlement When the modern states were created in 1824, the boundaries followed fairly closely the former political and ecclesiastical units But the centers of Spanish colonization in the sixteenth century were the mining towns, most of which were not established in the areas of concentrated Indian population Only Guadalajara, Toluca, Mexico City, and Tlaxcala, in the central region, were located in the midst of well-

populated country. The other towns — Aguascalientes, Guanajuato, Querétaro, Pachuca, Puebla, and Morelia — were mostly situated on the mountainous borders of the basins, and Indian workers were brought to these new places to labor in the silver mines. With the decline of mining prosperity in many of the older towns, the political centers of the states have actually declined in population, and new towns, located this time in the zones of dense settlement, have started to grow.

This situation is illustrated nicely by the town of Guanajuato, which forms the political center, but not the population nucleus, of the state of Guanajuato. The old Spanish mining town of Guanajuato had a population of 70,000 in 1880, but of only 16,000 in 1930. Meanwhile the towns of Celaya, Irapuato, and León are growing rapidly. These are in the midst of the area of concentrated settlement and have come into prominence only in the modern period. But the state boundaries were drawn with reference to the Spanish pattern of settlement. Only Jalisco and Tlaxcala were based on Indian culture areas. Jalisco, with its central town of Guadalajara, which was both a mining community and the center of a nucleus of settlement, has remained simple in structure. Tlaxcala has lost its original identity by expansion into neighboring Puebla.

CONCLUSION

These peculiarities are of interest because they form exceptions to the prevailingly simple geopolitical structures of Latin-American states. They are of interest also because they offer a previously unnoticed example of the geographical results of historical processes, and because they bear witness to the notable lack of adjustment between the cultural features developed by the Indians and by the Europeans in the same areas. But do they have any other importance? Do they throw light on any principles in the evolution of human institutions which would increase our understanding of social processes? Is there any practical significance in terms of the nature of the political, social, or economic problems of living in these regions? Are there any associated phenomena which would be clarified by recognizing the exceptional character of these areas? The geographer, as a social scientist, cannot be unaware of the challenge contained in these questions.

University of Michigan

EFFECTS OF THE GREAT LAKES ON THE ANNUAL MARCH OF AIR TEMPERATURE IN THEIR VICINITY

JOHN LEIGHLY

IN THE present paper, particularly in the series of maps included in it, Figures 1–16, I report an investigation of the thermal influences of the Laurentian Great Lakes on the annual cycle of air temperature over the lands about them It is the sequel to a less thorough examination of maritime influences on the annual march of air temperature in California that I made a few years ago[1] California faces in only one direction toward the body of water that affects air temperatures over it It is, moreover, a mountainous country, in which the effects on air temperature of mountains, considered both as elevations of surface and as barriers to the circulation of air, are often inextricably mingled with the effects of the ocean A clearer expression of the thermal effects of a water body might be gained, it seemed, from the examination of temperatures in an area of less marked relief An ideal subject for investigation would be an island of appropriate area and low relief, the temperature data from which might be compared with those from over the surrounding water. I have not had access to temperature data from any such island[2]

The next best material for such an inquiry, it further seemed, might be provided by the surroundings of a lake or a group of lakes of sufficient size and situated in a region of low or moderate relief The surroundings of the Laurentian Great Lakes offer perhaps as good a field for examination of the phenomena to be investigated as may easily be found The Great Lakes are large enough to exert a

[1] "The Extremes of the Annual Temperature March with Particular Reference to California," *Univ Calif Publ in Geog*, 6 191–234 1938

[2] Stephen Jones, of the University of Hawaii, has made an inquiry into the marine influences recognizable in the annual march of air temperature in the Hawaiian Islands Only an abstract of his work, "Lags and Ranges of Temperature in Hawaii," has as yet been published (*Bull Am Meteorol Soc*, 21 324 1940)

measurable thermal effect, the land about them is of low or moderate relief, and abundant climatologic data are available from stations in their vicinity As will appear later, the "marine" — or, better, lacustrine — effects on the annual temperature march about them is not entirely uncomplicated by factors other than the simple turnover of heat in them, but these superimposed factors are not conspicuous about the middle and lower lakes of the system, Lakes Michigan, Huron, Erie, and Ontario

The general principles governing the thermal effects of a body of water on the air above it, and through advection on the air above adjoining land, are set forth in the paper cited in footnote 1, and require no more than a brief recapitulation here Among "active" surfaces exposed to solar radiation and to loss of heat to the atmosphere and to space the most conspicuous contrast in nature is that between surfaces of land (solid) and of water (liquid) The water at surfaces of lakes or oceans being in more or less intense turbulent movement, the heat produced by absorption of solar radiation is transmitted downward to a depth dependent upon the intensity of turbulence in the surface layer of water It is thus imparted to a mass of matter having a much larger heat capacity than has the thin layer of soil or rock to which the same amount of heat derived from solar radiation falling on land is imparted Hence, although the amount of radiation absorbed by an open water surface is probably on the average slightly larger than that absorbed by a land surface, the surface itself, upon which the overlying air depends for most of its heat, remains cooler than the surface of the land The heat accumulated below is available in winter, however, to maintain the surface at a notably higher temperature, against the loss of heat to cold air and by outward radiation to space, than can be maintained by a land surface under the same conditions Efficient storage of heat in summer requires that it be distributed through a large quantity of matter having a high specific heat It is further essential that the temperature of the matter to which the heat is imparted remain relatively low, since the higher the temperature attained by its surface the greater will be the loss of heat to the atmosphere and to space during the warm season, and hence the less will be available to maintain the temperature of the surface in winter

Approximate equality in insolation and transparency being assumed, differences between different water masses in their effective-

ness as seasonal reservoirs of heat depend upon differences in the intensity of turbulent movement in their surface layers Transmission of heat downward into a body of water through the turbulent mixing of warmed surface water with cooler water below is a process that requires the expenditure of energy, since a column of water warmed at the top is highly stable In lakes this energy must be supplied from outside the water body itself, almost entirely from the shear exerted on their surfaces by wind Thus heat storage in a large lake, over which there is a long wind fetch, is greater than in a small one, and the stronger the circulation of air over the lake the deeper will turbulence extend and the more effective will be the storage of heat in the body of water

The measure of the thermal effect of a water body on the air above it is the excess of its annual heat turnover above the heat turnover in soil exposed to the same annual march of insolation Few measurements of this quantity are available An indirect measure may be derived from the qualities of the annual temperature march in air above the water and above neighboring land Temperature observations from above water bodies also are scarce In the process of circulation of the atmosphere, however, there is an interchange of air from above adjacent water and land surfaces, so that marine or lacustrine thermal effects extend to adjacent lands, becoming less distinct with increasing distance from the shore Undoubtedly a reciprocal "continental" effect of the land on the thermal régime of the air above the water also exists Such data, therefore, as are represented on the accompanying maps provide, if they can be rightly interpreted, a measure of the effectiveness of water bodies as reservoirs of heat

All the elements of the annual march of air temperature over lands near bodies of water are affected by the heat régime of those bodies If the march of insolation is the same the daily increase in income of solar radiation in spring produces a more rapid rise in the temperature of the land surface than in that of the water surface As the maximum of the annual march of insolation passes with the summer solstice, the land surface attains a higher maximum temperature than does the water The maximum of the annual march of temperature at the water surface is delayed longer after the maximum of the curve of insolation at the summer solstice than is the maximum of the march at the land surface

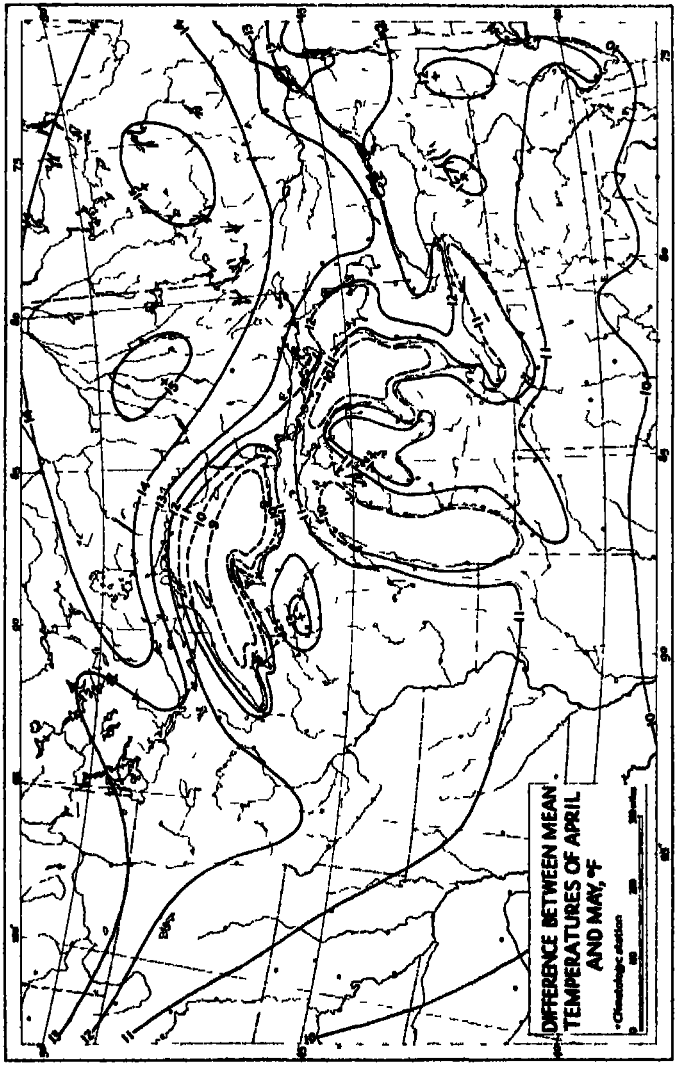
DIFFERENCE BETWEEN MEAN TEMPERATURES OF APRIL AND MAY, °F
• Climatologic station

FIG 1

In the declining phase of the annual march, in autumn, both water and land lose heat more rapidly than they receive it by absorption of solar radiation, and temperatures fall throughout the depths affected by the summer heating The large amount of heat accumulated below the water surface, and the easy transfer of this heat to the cooling surface by free convective overturning, make the rate of cooling at the water surface less than at the land surface The minimum attained at the trough of the annual wave of temperature is therefore higher The minimum of the temperature march over water, like the maximum, is delayed longer after the winter solstice than is the minimum at the surface of the land The difference between the maximum and minimum of the annual march of temperature is therefore less at the water surface, with its lower maximum and higher minimum, than at the land surface The layers of air close to the surfaces of water and land, which follow closely the temperatures of their substrata, display the same qualities of annual march of temperature, though in less extreme degree, as do these surfaces themselves

THE ARRAY OF DATA

Measures of the qualities of the annual march of temperature just enumerated — rate of rise in spring, temperature and date of maximum, rate of fall in autumn, temperature and date of minimum, and annual range - - obtained from mean air temperatures from more than four hundred stations at greater or less distances from the Great Lakes, are presented by means of isarithms in Figures 1–7 The area used in the base map for these figures as "the vicinity of the Great Lakes" was taken generously, so as to insure that all the area within which the lakes exert a perceptible thermal influence appeared and that sufficient territory in addition was included to obtain a representation of the courses of the isarithms outside the area of lacustrine influence In selecting stations preference was given, where a choice was possible, to ones in smaller places in the neighborhood of large cities over those in the cities themselves Records shorter than twenty years were used with reservation No reduction to a common period was made [3] A denser net of stations

[3] Mean temperatures taken from the *Climatic Summary of the United States by Sections*, issued by the United States Weather Bureau (edition giving means to 1930), were used directly for the parts of the United States included in the

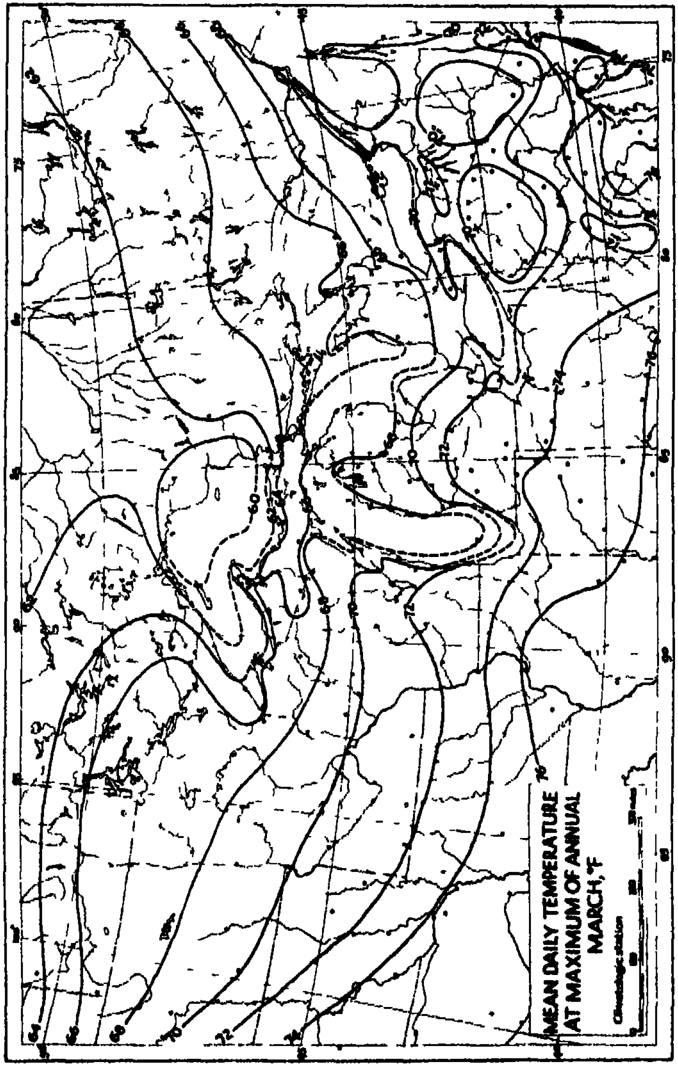

FIG 2

was used in the immediate vicinity of the lakes than at greater distances from them

Rate of rise of temperature in spring is indicated in Figure 1, a map of difference between the mean temperatures of April and May, and rate of fall of temperature in autumn in Figure 4, by difference between the mean temperatures of October and November Such quantities are not the best measures of rate of change in mean temperature that might be used A better measure would be the slope of the annual temperature curve at its steepest points in spring and autumn, expressed as degrees change per unit of time In order to obtain these quantities it would be necessary to draw smooth curves of annual temperature march from monthly means, to identify the points of steepest slope, and to measure the inclination of the curves at those points Each step in the process would be strongly affected by personal judgment The differences between monthly means used in Figures 1 and 4 have the advantages of being easier to compute and of being free from any subjective quality

Figures 2 and 5 are maps of mean daily temperatures at the maximum and at the minimum of the annual march These temperatures were obtained by interpolation from monthly means with the aid of the diagram published as Figure 15 of the paper cited in footnote 1 Figures 3 and 6 represent delays of the maximum and the minimum of the annual march after the summer and winter solstices They were obtained from monthly means by use of Figures 9 and 10 of the paper just mentioned Figure 7 is the difference obtained by subtracting the data of Figure 5 from those of Figure 2

Isarithms drawn on the lake surfaces are broken to indicate the uncertainty of their courses In most instances these isarithms do not represent, as may appear at first glance, extrapolations beyond the values pertaining to coastal stations On Figure 1, however, the closed isarithm of 9° on Lake Superior and that of 10° on Lake Huron do represent slight but not unreasonable extrapolations the former beyond 9 2° at Eagle Harbor, Michigan, the latter beyond 10 3° at Harbor Beach and 10 6° at Harrisville, Michigan, and beyond 10 5° at Goderich and 10 9° at Southampton, Ontario

base map Data for Canadian stations were taken from the *Monthly Record of Meteorological Observations*, published by the Canadian Meteorological Division I am indebted to Mr J Patterson, Controller of the Meteorological Division, for information concerning lengths of records at Canadian stations, which is not given in the *Monthly Record*

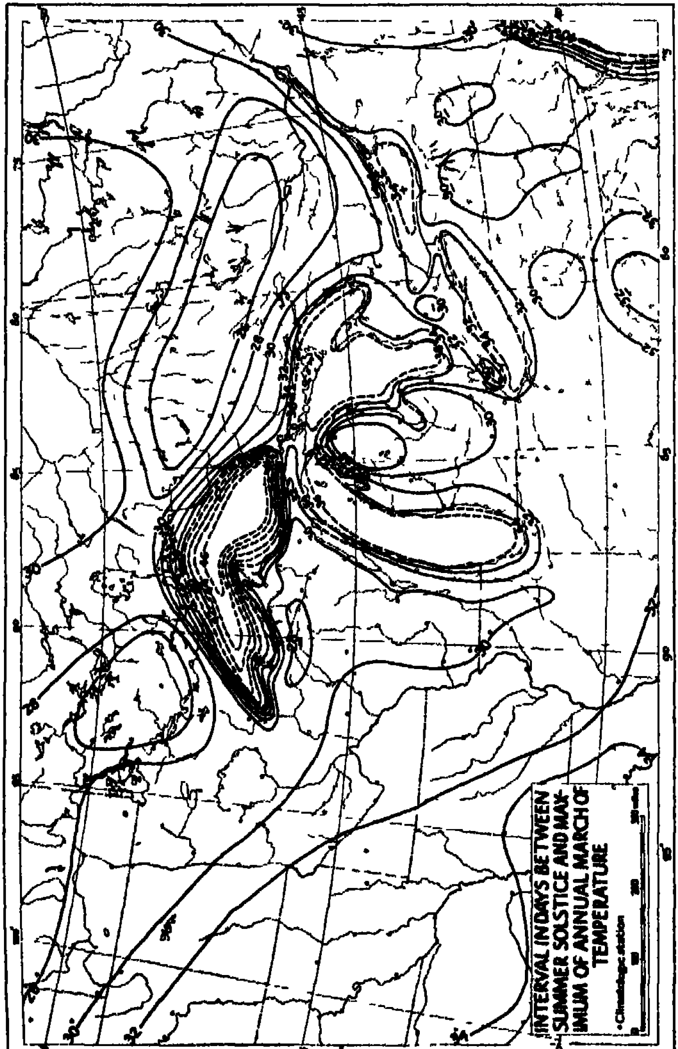
INTERVAL IN DAYS BETWEEN SUMMER SOLSTICE AND MAXIMUM OF ANNUAL MARCH OF TEMPERATURE
• Climatologic station

FIG 3

DISTRIBUTION OF THE ELEMENTS OF THE ANNUAL MARCH

Into the maps reproduced in Figures 1–5 the Great Lakes introduce a characteristic pattern of distortion of the isarithms This distortion appears most unequivocally and in greatest detail to the south and west of the lakes, where stations are closely spaced and relief negligible North of the upper lakes the sparseness of stations makes the detailed courses of the isarithms uncertain, but stations are sufficiently numerous to permit their general courses to be easily recognized

Outside the neighborhood of the lakes the fields of distribution of the elements of the annual march of temperature are most disturbed toward the southeast Certainly the Appalachian highland crowds closely upon the field of distortion of the temperature march by the lakes, especially in winter It is also possible that the influence of the Atlantic may extend inland to overlap in this mountainous area the effects of the lakes The seriousness of this difficulty is mitigated by the fact that the bodies of water most immediately concerned, Lakes Ontario and Erie, are also those whose thermal influences close at hand are weakest, the influence of the mountains and the Atlantic may therefore also be expected to be correspondingly restricted in area

Outside the fields of distortion produced by the lakes the characteristic pattern of the isarithms in Figures 1, 2, 4, and 5 is a gradation of the quantities mapped, the gradients of the fields of the elements being oriented north–south In Figures 1 and 4 this gradation reflects the qualities of the annual march of temperature summarized in the familiar increase in annual range of temperature with increasing latitude Other factors than latitude are, however, involved In Figure 1, the locus of most rapid warming is in the northeastern part of the area mapped, whereas in Figure 4 the locus of most rapid cooling is in its northwestern part Probably this difference reflects primarily differences between spring and autumn in water-vapor content of the air These differences in turn are dependent on the importation of maritime air Within the area covered by the map the principal source of maritime air in winter is the Pacific Ocean, in summer, the Atlantic The locus of greatest continentality therefore shifts with the seasonal change from spring to autumn

The isotherms of temperature at the extremes of the annual

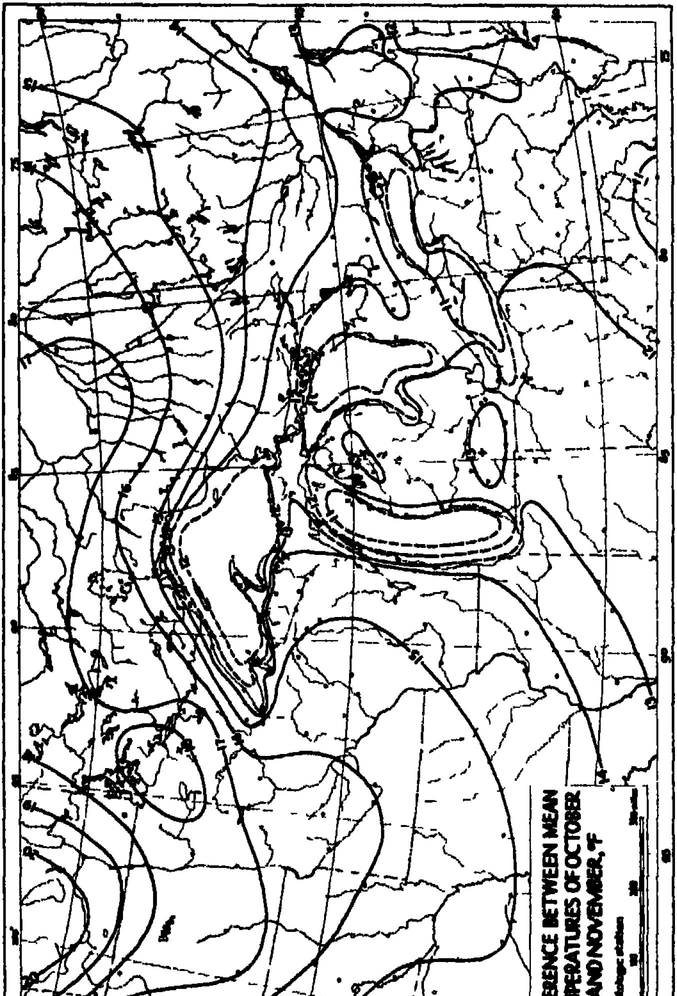
DIFFERENCE BETWEEN MEAN TEMPERATURES OF OCTOBER AND NOVEMBER, °F
• Climatologic station

Fig 4

march drawn in Figures 2 and 5 display no noteworthy asymmetry with respect to a meridian If the distortions introduced by the Great Lakes be thought of as absent, the pattern of isotherms in both extreme seasons would clearly be, in this part of North America, a pattern of roughly parallel lines, convex southward It is to be concluded from this pattern that the region about the Great Lakes would be the most continental part of the area represented in the base map, both in summer and in winter, if the lakes were not there

EVALUATION OF THE EFFECTS OF THE LAKES

The presence of the Great Lakes introduces a conspicuously heterogeneous element into the surface of the continent considered as an active surface maintaining a heat exchange with the sun, the atmosphere, and space The lakes therefore deform the field of surface temperature and hence the field of air temperature over the region in which they lie The deformation of the temperature field of the air introduced by them is recognizable in Figures 1–7 first by a bending of isarithms from the courses they would have if the surface of the continent were not interrupted by the lakes and secondly by the intrusion of closed isarithms lying over the lakes and the land in their immediate vicinity Because it is rather easy to recognize the courses the undisturbed isarithms would follow across the area in which they are in reality distorted by the presence of the lakes I have ventured to draw them in Figures 8–14

The maps reproduced in Figures 1 7 have counterparts in Figures 8–14 In preparing these latter maps the isarithms in Figures 1–7 were connected across the region about the lakes where they are distorted In Figures 8-14 those parts of the isarithms of the first seven figures that were accepted as undistorted are drawn with long dashes The parts interpolated across the distorted fields are drawn with short dashes A certain amount of subjectivity is involved in the construction, more in some instances than in others Figure 5, with its close spacing of isotherms, was the easiest to interpolate, and the subjective element in Figure 12 is therefore correspondingly small It is also small in Figure 14, derived from Figure 7 As the pattern of undisturbed isarithms on the primary maps becomes less evident, as in Figures 3 and 6, the subjective element in construction of the undistorted fields becomes larger

When the isarithms defining the undistorted fields of the elements

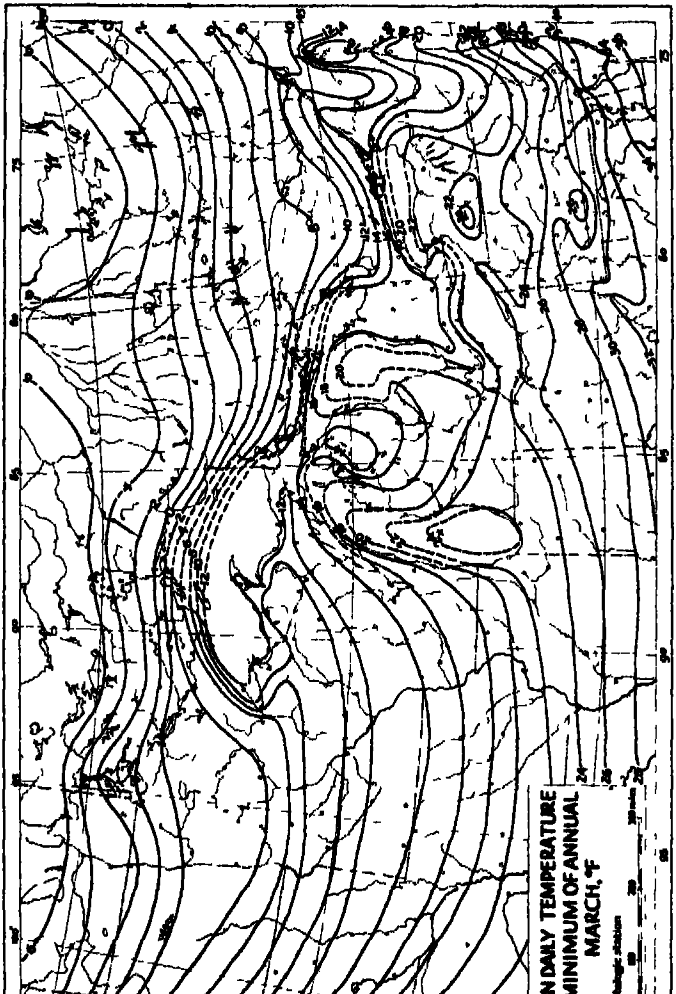

FIG 5

of the annual march of temperature had been drawn, subtraction of these undistorted fields from the actual distorted ones represented in Figures 1-7 gave the isarithms shown as heavy full lines in Figures 8–14 Subtraction of the fields was performed graphically The isarithms of the undistorted fields were drawn on sheets of tracing paper which were then laid over Figures 1–7 Wherever one of the undistorted isarithms crossed one of the actual isarithms on the primary map the difference between the numerical values of the undistorted and the actual isarithms was marked down at the point of intersection Thereby the differences between the two fields were obtained at a number of points, in the same manner as all climatologic data, primary or derived, are given Isarithms were then drawn among these points to indicate the complete fields of effect of the lakes on the several elements of the annual temperature march, in the manner represented in Figures 8-14 Since the undistorted isarithms run across land and water surfaces alike, some points of intersection, and hence points at which differences between distorted and undistorted fields were determined, came to lie on the lake surfaces themselves These points gave rise to closed isarithms lying wholly inside the peripheries of lake surfaces, as in Figures 8, 10, and 14 I estimate that the subjective element involved in drawing the isarithms of the undistorted fields makes the data of Figures 8 14 uncertain by not more than one interval between the isarithms drawn

I shall not comment on the details of the distribution of intensity of the thermal effects of the Great Lakes recorded in Figures 8–14 It will be obvious to the reader that the position of the zero lines, which presumably mark the outer limits of thermal effect of the lakes, is particularly uncertain As drawn, these lines represent no more than my judgment as to where, in the courses of the isarithms of Figures 1–7, inflection resulting from the presence of the lakes begins and ends I have therefore drawn them as lighter lines than are used for the other isarithms Some common qualities run through all the seven maps Lake Superior generally exerts a stronger effect on the elements mapped than does any of the other lakes Lakes Huron and Michigan come next in strength of effect, having values usually not far below those of Lake Superior Erie and Ontario fall far behind the upper lakes on every map

Because each map of the series reproduced in Figures 8-13 includes an uncertainty resulting from the subjective element intro-

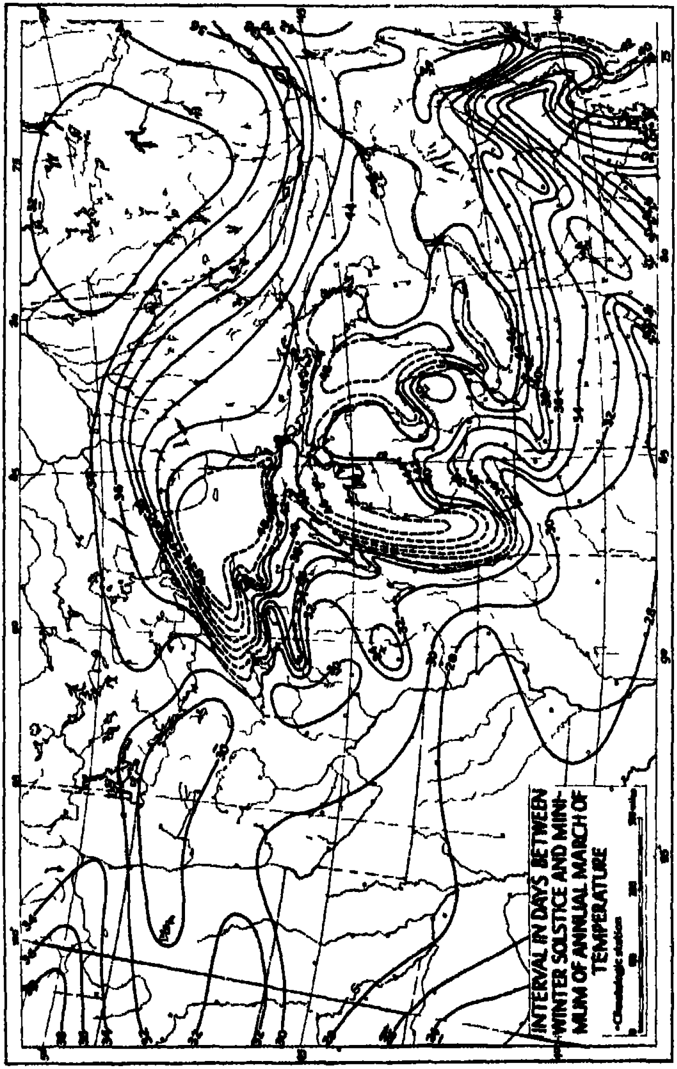
INTERVAL IN DAYS BETWEEN WINTER SOLSTICE AND MINIMUM OF ANNUAL MARCH OF TEMPERATURE

Fig 6

duced in the process of its construction, I have combined in Figure 15 the several "effects" into two groups designated "summer" and "winter," in the belief that some of the uncertainty of the construction might thus be canceled Summer effects are derived from Figures 8 10, winter effects, from Figures 11–13 An appropriate value on the original scale was assigned to the point of maximum at the middle of the area enclosed by the isarithm of highest value on each map, and then given the value five on an arbitrary scale The maximum of the arbitrary scale being thus taken at five, isarithms for one, two, three, and four on this arbitrary scale were interpolated among the isarithms of the original maps The zero isarithms were of course the same as on the original maps Thus the data on all three of the original maps pertaining to one season were put into a comparable scale of variation The corresponding isarithms — zeros, ones, twos, threes, and fours — were then traced separately on tracing paper, and a median isarithm drawn for each These median isarithms were then transferred to the map in Figure 15 Winter isarithms on it thus measure the processes pertaining to the fall of temperature to its minimum, summer isarithms the processes pertaining to its rise to a maximum In accordance with the more intense circulation of winter, the mean winter effect is distributed over a wider area, and more nearly evenly over it, than is the mean summer effect The summer effect is more sharply limited in area, having a marked concentration over Lake Superior, which reflects especially the concentration represented in Figure 10

In Figure 16 the data of Figure 15 are generalized still further, in the form of circles having areas equal to the areas enclosed by the zero isarithms of the preceding figure The "mean effects" over these circles were obtained by measuring with a planimeter the areas enclosed within the several isarithms of Figure 15, each area being weighted according to the mean of the two isarithms bounding it Their sum was then distributed over the entire area enclosed by the respective zero isarithms and by the equivalent circles The weighted means are the values 1 43 and 1 08 entered in Figure 16 Though the annual heat turnover involves the accumulation in summer and dissipation in winter of the same quantity of heat, the effect of the release of heat in winter is more conspicuous in the temperature régimes of the land stations than is the effect of its accumulation in summer The difference is probably the consequence of more intense horizontal

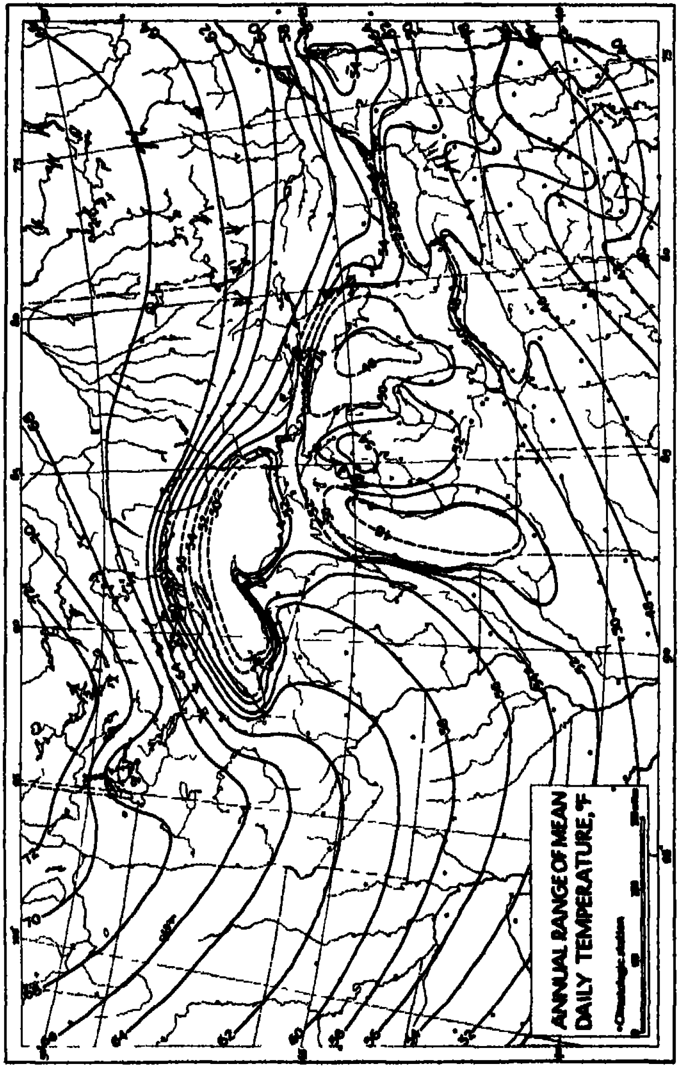

Fig 7

mixing in winter than in summer, combined with greater general stability of the air at the former season The heat exchange in summer is evidently more highly concentrated in the air immediately above the surfaces of the lakes, and so affects the temperatures of the land stations less profoundly than does the winter phase of the heat turnover

The circles representing seasonal "effect" of the lakes in Figure 16 are centered at the median points of the areas enclosed by the isanthms of Figure 15 These median points were found by the usual procedure Trial coordinate axes, the Y-axis a meridian, were drawn by estimate Then with the aid of a planimeter the weighted total effect in each of the quadrants thus defined was determined By balancing the weighted totals to right and left of the Y-axis and above and below the X-axis, the axes were next shifted so as to divide the fields equally in both directions The points of intersection of these final axes are the median points in Figure 16 The median point of the area of the lakes was determined in the same manner [4] The median points of the total effects in both summer and winter lie north of the median point of area of the lakes, but at no great distance from it The median point of the summer effect, "MS," is in about the same longitude as the median point of area of the lake surfaces, whereas the point "MW" lies slightly farther to the east I made this construction in order to determine to what extent the resultant wind vector, which is directed eastward at both extreme seasons (arrows "S" and "W" of Figure 16) transports the thermal effects of the lakes eastward The transport is less than might be expected But the positions of the median points may not be an

[4] Measurements for determining the median point of the water area of the lakes were performed on a pantographed reduction, to half the scale, of the Corps of Engineers' "General Chart of the Northern and Northwestern Lakes" (scale, 1 1,200,000), (1925 ed) In the course of these measurements I also determined the median point of the volume of water in the five Great Lakes, using the isobaths of the chart just mentioned Though the result has no bearing on the matter of the present paper it may be of some general interest The median point of the volume of the Great Lakes, I found, is in latitude 46° 52′ N , longitude 86° 47′ W , about thirty-four miles north and slightly west of Munising, Michigan, thus well within the area of Lake Superior The part of Lake Superior lying north of the east–west axis passing through this point thus contains as much water as all the other lakes combined, and in addition an appreciable fraction of the volume of Lake Superior itself Few other facts emphasize so strongly the comparative capacities of the basins of the lakes, in which the greater average depth of Lake Superior gives it an advantage not immediately evident from its area

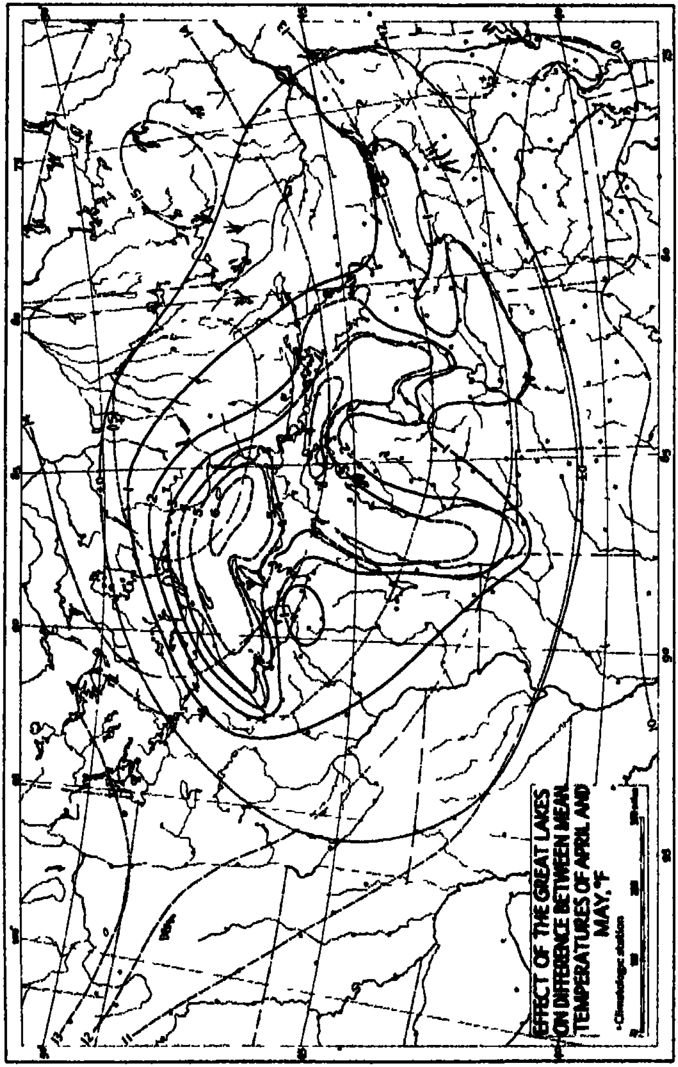
EFFECT OF THE GREAT LAKES
ON DIFFERENCE BETWEEN MEAN
TEMPERATURES OF APRIL AND
MAY, °F
• Climatologic station

Fig 8

entirely adequate measure of the transport of the thermal effects of the lakes by the circulation of air over and about them Certainly if Lake Superior did not weigh so heavily in the computation of the positions of the median points, especially that for summer, they would lie farther east and farther south The eccentricity of the zero isarithms in Figure 15 is not, however, so great as might be expected The circulation of the air about the lakes, it is clear, is sufficiently variable to carry their thermal effects in all directions, with only a moderate dominance of the eastward net transport [5]

THEORETICAL CONSIDERATIONS

The primary effect of a water body on the march of temperature in the air above it depends upon the storage of an appreciable fraction of the heat produced by absorption of the solar radiation that falls on it during the summer, and the liberation of that heat to maintain the temperature of the overlying air in winter Liberation of heat in winter is not prevented by a cover of ice, for it proceeds, though perhaps at a slower rate, through an ice cover as well as when the surface of the water is unfrozen Examination of Figures 12 and 13 discloses no systematic difference between the thermal effects of the normally frozen surfaces of Lake Superior and the northern parts of Lakes Michigan and Huron on the one hand and those of the less frequently frozen lakes farther south From these maps, and from Figures 8, 9, 11, and 14, it appears that the effect of any one lake varies directly with its area and inversely with the temperature of the air over the land surface about it

The same generalization cannot legitimately be made concerning the effect of the lakes on the delay of the maximum of the annual temperature march, recorded in Figure 10 The influence of Lake Superior is here grossly disproportionate to the ratio of its area to the areas of the other lakes Some factor other than heat turnover and wind fetch is clearly active in summer over this largest and coldest of the lakes

[5] The resultant wind vectors drawn in Figure 16, with lengths proportional to mean velocity in the summer and winter quarters of the year, are computed from means of the resultants at the surface, at 500 meters, and at 1,000 meters at the stations composing Group 2 (Burlington, Vt , Ithaca, N Y , Lansing, Mich , and Madison, Wis) of the arrangement of material in Willis Ray Gregg's "An Aerological Survey of the United States, Part II, Results of Observations by Means of Pilot Balloons," *Monthly Weather Rev* , Suppl 26 57 1926

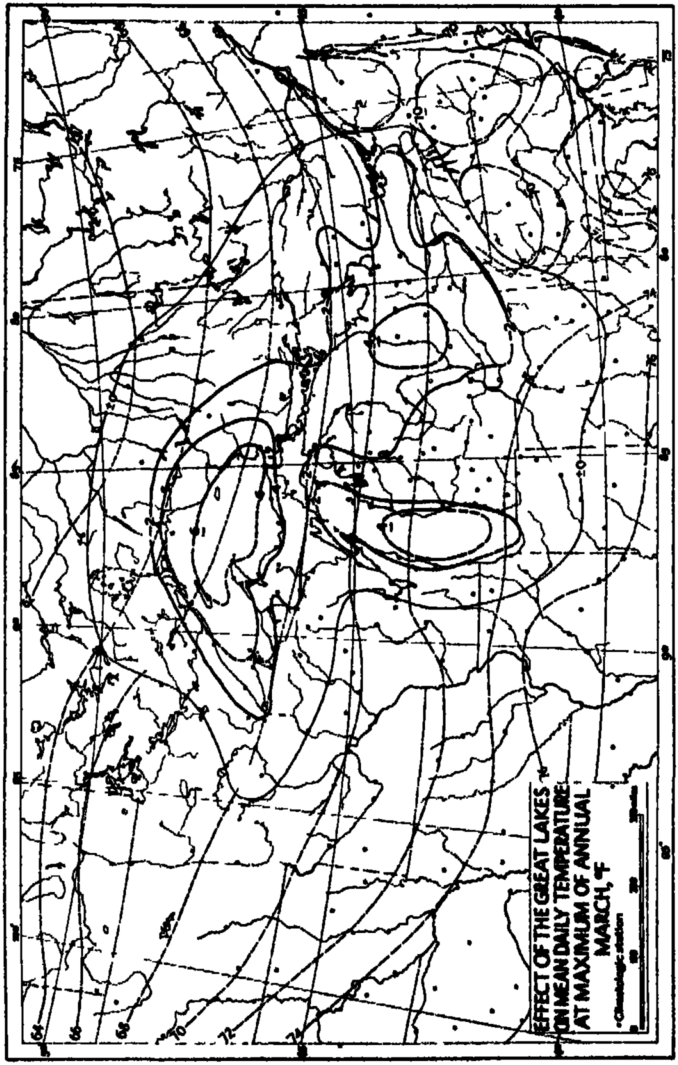
EFFECT OF THE GREAT LAKES
ON MEAN DAILY TEMPERATURE
AT MAXIMUM OF ANNUAL
MARCH, °F

FIG 9

It is not necessary to seek far for a circumstance that affects the heat economy of Lake Superior in summer to a greater degree than the heat economies of the other lakes The key to its identification is given in the data of frequency of fog over the lakes, which have been compiled and mapped by Robert G Stone[6] Fog over the Great Lakes is principally a phenomenon of the warm season, the consequence of a reduction of the temperature of air from above the surrounding land by the cool waters Among the lakes the difference between air and water temperatures is largest over Lake Superior, and the frequency of summer fog over it consequently greatest

In the absence of measurements of solar radiation there is no way of knowing how the annual curve of insolation is distorted in summer by fog over Lake Superior, that is, to what extent and in what sense its maximum is shifted from the summer solstice There may be some such asymmetry of the insolation curve in summer, but it is not necessary that it be asymmetrical in order that the temperature curve may be so

The empirical evidence of observed annual temperature curves shows that progressive flattening of the curves at either extreme is normally associated with an increase in the delay of the extreme In the paper cited in footnote 1 I have presented the reason for this association, in so far as the march of temperature is determined by heat turnover in the immediate substratum, whether earth or water The relation is not quite so obvious where, as over the land areas about the Great Lakes, the heat exchange of the climatologic air that manifests itself in the maps of effect of the lakes is maintained primarily by horizontal components of turbulent mixing in the atmosphere Some further elucidation is in order

Let the curve I_1 in Figure 17A represent the rate of absorption of insolation near the minimum of its annual march by an active terrestrial surface This curve does not represent total insolation, such as is measured by a solarimeter, but that fraction of the total which is absorbed, a fraction that depends on the albedo of the surface It will here be called "effective insolation" The temperature of the surface to which daily amounts of heat are added at the successive rates represented by the curve tends constantly toward equilibrium with its income of radiant energy While the insolation

[6] "Fog in the United States and Adjacent Regions," *Geog Rev*, 26 111–134, fig 1 (p 112) 1936

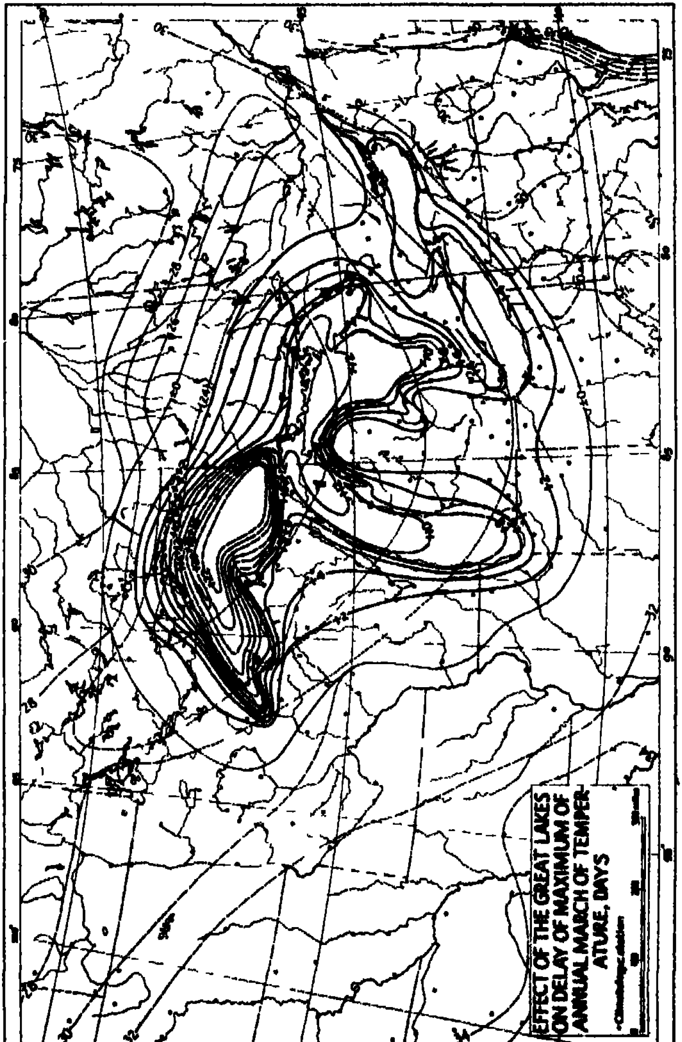
EFFECT OF THE GREAT LAKES ON DELAY OF MAXIMUM OF ANNUAL MARCH OF TEMPERATURE, DAYS

FIG 10

curve is falling, the surface is too warm to permit that equilibrium to be attained, and therefore it is not attained until after the insolation curve has passed its minimum, and started upward again The change in temperature implied by the tendency toward equilibrium at this time of year is a fall in temperature of the surface, as a consequence of which heat is transferred to the surface from the underlying substratum Since at the minimum of the annual march of insolation the loss of heat from the substratum has been in progress for several months, the amount of heat being brought to the surface is below the maximum transfer of some months earlier, and this amount decreases daily with the progressive exhaustion of the supply accumulated during the preceding summer The curve of supply of heat from the substratum therefore has some such shape as curve S of the figure, drawn as gain to the active surface, and so above the axis of abscissas O Curves such as S will here be called "curves of heat transfer" If curves I_1 and S represent the total amount of heat received by the active surface, this total is given by curve Q_1, drawn by adding the ordinates of I_1 and S If loss of heat proceeds normally, and if the amount of matter affected by the heat turnover remains constant, the curve Q_1 will also represent the march of temperature at the surface resulting from the reception of the quantity of heat $(I_1 + S)$ It is clear that the minimum of curve Q_1 must fall later than the minimum of curve I_1 it is shifted to the right in the figure to the point, marked by a small arrow, at which the positive slope of I_1 equals the negative slope of S

If S represents the amount of heat delivered to the surface from a substratum in which there is a small turnover of heat — a substratum of dry soil or rock, for example — the curve representing the amount delivered by a substratum having a large heat turnover, such as a large lake or the ocean, will be represented by a curve resembling S' Under the same assumptions made concerning S and Q_1, the curve Q'_1 will then represent the march of temperature at the active surface In accordance with the steeper slope of curve S' as compared with S, the minimum of the curve Q'_1, again marked by an arrow, falls later than the minimum of curve Q_1

The same reasoning is applicable to the maximum of the insolation curve having the shape of I_1, which is drawn as I_2 in Figure 17C At the maximum, heat is being transferred *from* the active surface into the substratum, so that curves S and S' are now negative, and

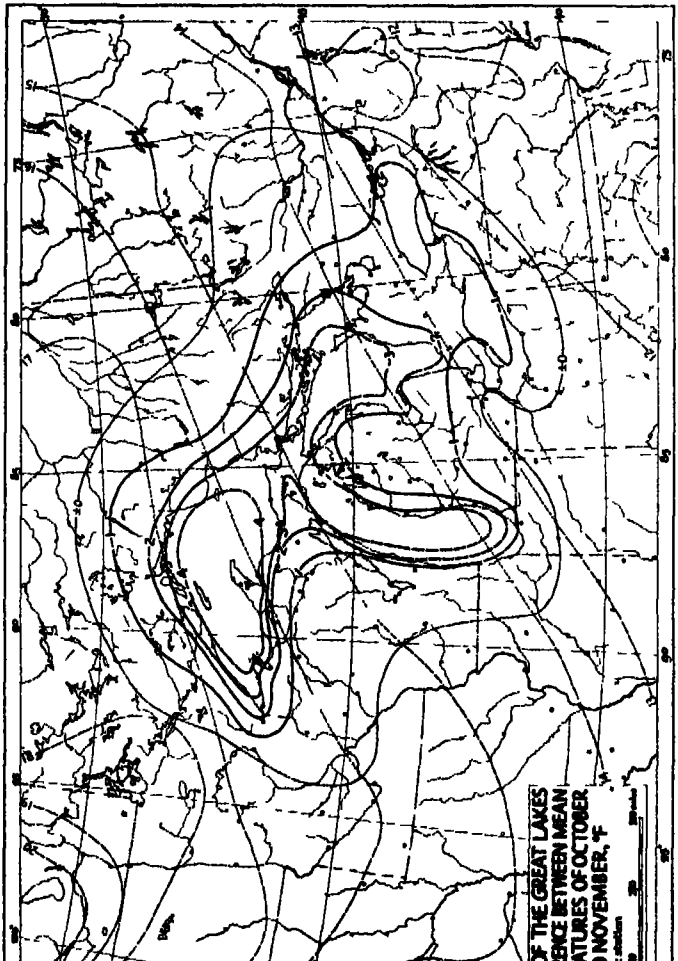
EFFECT OF THE GREAT LAKES
ON DIFFERENCE BETWEEN MEAN
TEMPERATURES OF OCTOBER
AND NOVEMBER, °F
Climatologic station

FIG 11

the algebraic sum of I_3 and S or S' gives curves Q_3 and Q'_3 respectively, which have lower maxima than I_3. The delays of the maxima of temperature, which depend on the forms of the curves of effective insolation and heat transfer, are the same as in Figure 17A.

The curve that represents the heat economy of the matter that determines the temperature of the climatologic air is the sum of an insolation curve resembling curves I_1, I_2, I_3, or I_4 of Figure 17, and of one or more curves of heat transfer, indicated in Figure 17 by curves S and S'. The matter with which the climatologic air is most closely bound in its annual march of temperature is that which is exposed to form the local actively receiving and emitting surface. Since at the maximum of the annual march this surface is normally the warmest part of the system within which the local heat turnover proceeds, and its coldest part at the minimum, the local curve of heat transfer at the minimum will normally be positive, as in Figure 17 A–B, and negative at the maximum, as in Figure 17 C–D. The total heat transfer usually includes both "autochthonous" heat, produced locally and accumulated in the local substratum, and some "allochthonous" heat, produced by the absorption of solar radiation elsewhere and brought to the locality under consideration by advective processes in the atmosphere or in water. A part of the heat produced locally in summer may in turn be transported elsewhere. Thus the heat available to maintain the temperature of the local active surface and that of the superjacent air in winter is normally partly autochthonous and partly allochthonous.

Whether the heat goes exclusively through a local cycle of heat turnover or is brought from elsewhere, the curves of heat transfer will have, on the average, the shape of the curves S and S' in Figure 17. This shape follows from the fact that at the minimum of the temperature march the supply of heat available for transport to the local climatologic air, whether from the local substratum or from elsewhere, is well advanced in its hemicycle of depletion.[7]

[7] F. Baur and H. Philipps have published in Figure 6 (p. 131) of "Der Wärmehaushalt der Lufthülle der Nordhalbkugel im Januar und Juli und zur Zeit der Äquinoktien und Solstitien. 2. Mitteilung, Ausstrahlung, Gegenstrahlung und meridionaler Wärmetransport bei normaler Solarkonstante" (*Gerlands Beiträge zur Geophysik*, 45: 82–132. 1935) a curve of heat accumulation through the year in the whole complex of soil, air, and sea in the northern hemisphere, including both hemicycles, namely, of accumulation and depletion. It is clear from this curve that the amount of heat accumulated in the bodies of matter in which the hemispheric heat turnover proceeds is at a maximum in late August and at a

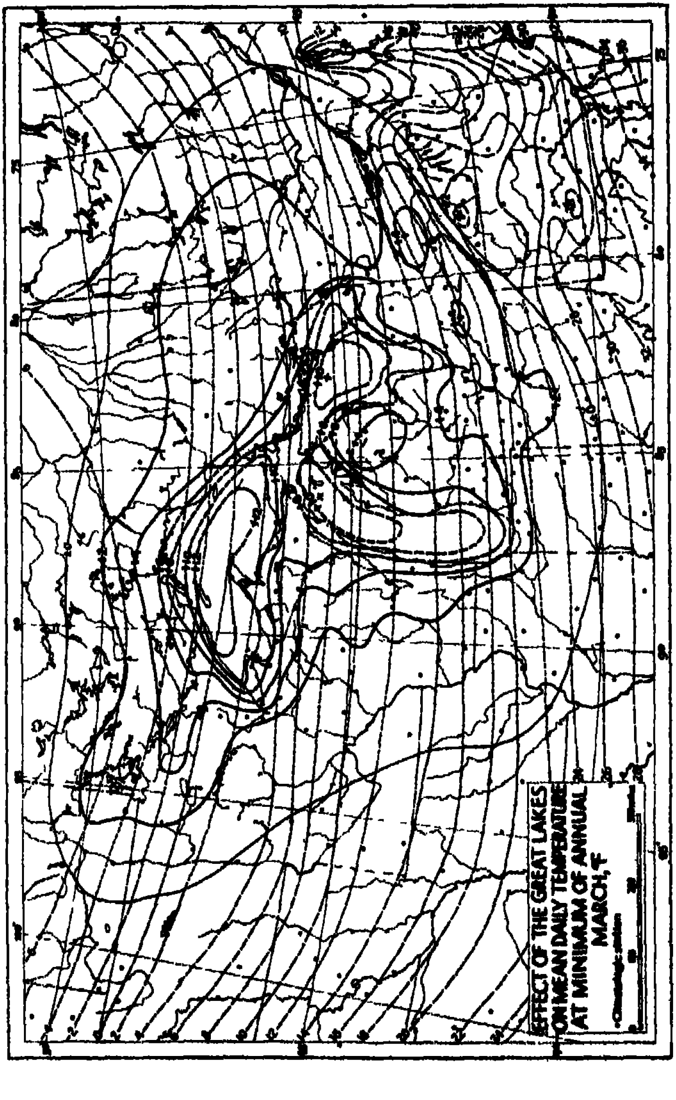
EFFECT OF THE GREAT LAKES
ON MEAN DAILY TEMPERATURE
AT MINIMUM OF ANNUAL
MARCH, °F

Fig 12

The rate at which it is delivered to the local active surface or to the local climatologic air is therefore decreasing at the time of the minimum of the insolation curve The date of the extreme of temperature depends both on the shape of the insolation curve and on that of the curve of heat transfer Given a certain shape of the insolation curve, the greater the rate of change of heat transfer (decrease at the minimum, increase at the maximum), the greater will be the delay of the extreme after the solstice The steepness of the curve of heat transfer will ordinarily vary with the amount of heat transferred in the course of the yearly turnover, since the length of the annual cycle is everywhere and always the same, whereas the amplitude of the curve of heat transfer increases with the total amount of the annual turnover of heat The greater the heat turnover, moreover, the later does the curve of local heat transfer cross the ordinate zero and thus enter the hemicycle of opposite sign from accumulation to depletion in late summer, and from depletion to accumulation in late winter [8] Account was taken of this fact in drawing curves S and S' in Figure 17 S is made to reach the ordinate zero at the edge of the drawing, thus relatively soon after the solstice, whereas S' has at the same time a finite value, positive or negative depending on the season The factors that determine the dates of the extremes of temperature are the slope of the curve of effective insolation near its extremes, and the slope of the curve of total heat transfer at the same time, not the amounts of heat provided by insolation and heat transfer Hence the same date of extreme may occur through a wide range of temperature, and the same temperature at the extreme through a wide range of date

The shape of the insolation curve depends on latitude, cloudiness, and albedo of the active surface Given an albedo that is approximately constant through the year (a condition fulfilled in snow-free regions), the extremes of the insolation curve become sharper with increasing latitude A winter snow cover, by increasing greatly the albedo of the surface, increases the amplitude of the annual insolation curve, and so makes the minimum sharper than it would be if the surface remained free of snow Cloudiness in winter exerts the

minimum in late February In this hemispheric mean the influence of the seas undoubtedly predominates over that of the continents This consideration was in mind when curves S and S' in Figure 17 were drawn

[8] Compare Figure 7 d–f (p 209), of the paper cited in footnote 1

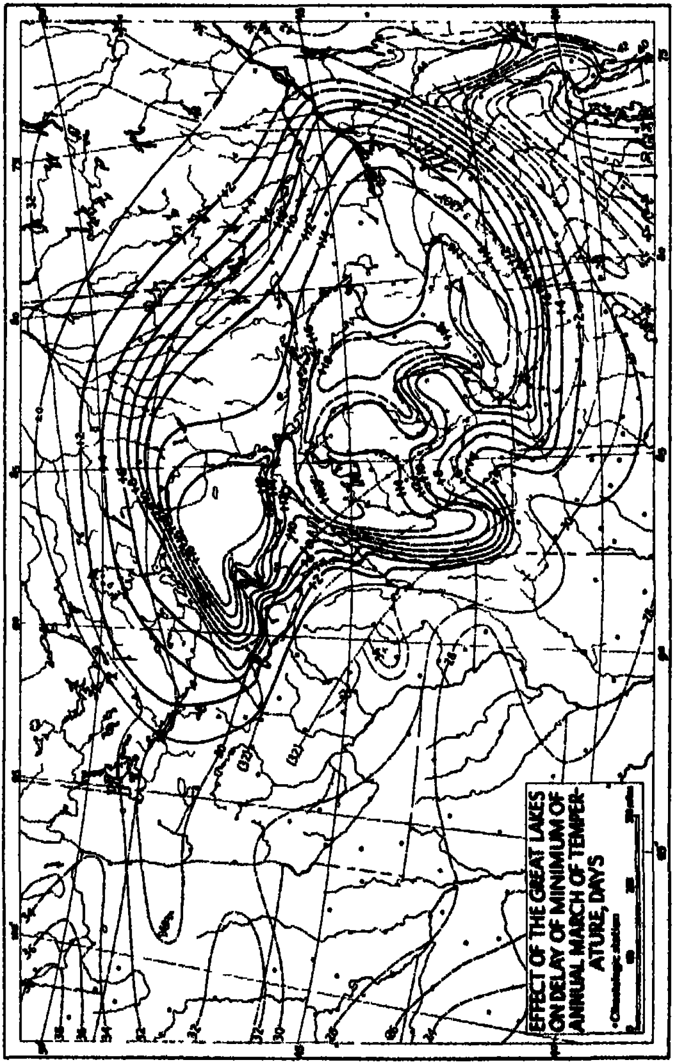
EFFECT OF THE GREAT LAKES ON DELAY OF MINIMUM OF ANNUAL MARCH OF TEMPERATURE, DAYS
• Climatologic station

FIG 13

same effect[9] In summer, on the contrary, cloudiness blunts the maximum of the curve of effective insolation

In Figure 3, therefore, the general decrease in delay of the maximum northward toward a value of about twenty-six days north of the Great Lakes may be interpreted as the expression of a sharpening of the peak of the insolation curve toward the higher latitudes of the area included in the map As the insolation curve becomes sharper with increasing latitude, the temperature curve also becomes sharper, and this change in shape of the temperature curve is accompanied by a retreat of its maximum toward the summer solstice The march of insolation has a blunter maximum in the lower latitudes of the map, temperature curves are also blunter, and the delay of the maximum is larger than in higher latitudes Thus over the land surface in general the distribution of delay of the maximum may be rather simply interpreted on the basis of latitude and local heat turnover

The field of delay of minimum of the annual temperature march represented in the parts of Figure 6 beyond the range of effect of the Great Lakes, on the other hand, reflects the influence of factors other than latitude and local heat turnover The most conspicuous of these are proximity to the sea at the right of the map and a snow cover in all the territory covered by the map except its lower edge and lower right corner[10] The insolation curve, therefore, must become sharper northward within the range of latitude included in the map Yet the least delays within the area covered by the map are in its southwestern part, which is continental in its relation to the sea,

[9] The effect of a snow cover is not recognizable in records of measured insolation. That of a cover of cloud or fog is. Among the stations in the United States for which means of insolation measurements are available Fresno, California, provides the best example of the effect of fog at the minimum of the annual march In the San Joaquin Valley the dense and persistent valley fogs of winter reflect a large fraction of solar radiation, so that the curve of Fresno's mean radiation income in winter has the sharpest minimum of any station in the United States for which comparable data exist Compare the summary made by Irving F Hand in "Review of United States Weather Bureau Solar Radiation Investigations," *Monthly Weather Rev*, 65 415–441 1937

[10] Compare the map of mean number of days per year (not necessarily consecutive) with snow cover published as Figure 75 (p 43), in J B Kincer's "Precipitation and Humidity," *Atlas of American Agriculture*, Part II, Sec A 1922 In the western part of the area covered by the base map used in the present paper the isarithms of number of days with snow cover, other than that for thirty days, swing northward, as do the isarithms in the lower left of Figure 6

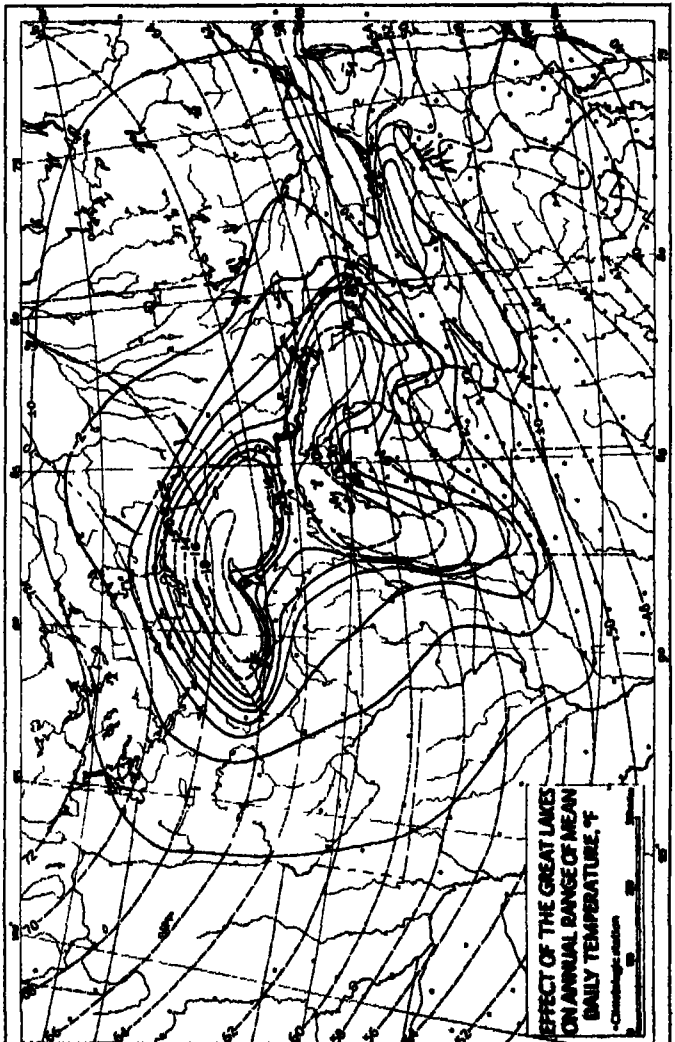
EFFECT OF THE GREAT LAKES
ON ANNUAL RANGE OF MEAN
DAILY TEMPERATURE, °F

Fig 14

and free of a continuous snow cover in winter Within the area having a regular snow cover the effect of heat transfer on the march of temperature at the minimum obviously obscures the effect of the sharp minima of the insolation curves [11]

What happens in areas having a regular snow cover is evidently this The high albedo of the snow reduces the effective insolation at the minimum of its annual march to a very small value Outward radiation from the snow cover proceeds at about the same rate as from a snow-free surface having the same temperature The temperature of the surface and of the air close to it therefore falls below the temperature of a snow-free surface exposed to the same conditions This fall in temperature steepens the temperature gradient in the atmosphere toward the snow-covered area from areas of higher air temperature At a given intensity of circulation of the atmosphere, the flux of heat toward the snow-covered area increases with the steepening of the temperature gradient toward it Thus a snow cover strongly favors the advection of allochthonous heat The rapid increase in delay northwestward at the upper left of Figure 6, in Saskatchewan and southeastern Manitoba, undoubtedly reflects an increase in the amount of allochthonous heat received, primarily through the agency of air arriving from over the Pacific Northern Quebec, in the same latitude, has a smaller delay, with the predominantly eastward movement of the atmosphere in this latitude, Quebec is in a less favorable position to receive heat from the sea in midwinter than is the far interior of the continent

INTERPRETATION

The general considerations stated above make the interpretation of the maps reproduced in Figures 8–13 relatively easy In Figure 8 the effect of the fogs of the warmer part of the year over the northern lakes already manifests itself in the spring rise of air temperature The spring rise of temperature of the water of the lakes is diminished

[11] Curves plotted from normal daily temperatures (published by Charles F Marvin and P C Day in "Normals of Daily Temperature for the United States," *Monthly Weather Rev*, Suppl 25 1925) have sharper minima at the stations within the area with persistent snow cover than at those outside it It will be noted that in Figure 17 A and C, the addition of a curve of heat transfer of the form of *S* or *S'* to an insolation curve yields a curve of total heat supply sharper than the insolation curve This association of sharper minimum of the temperature curve with greater delay of the minimum at stations within the area having a regular snow cover supports the argument made in the text

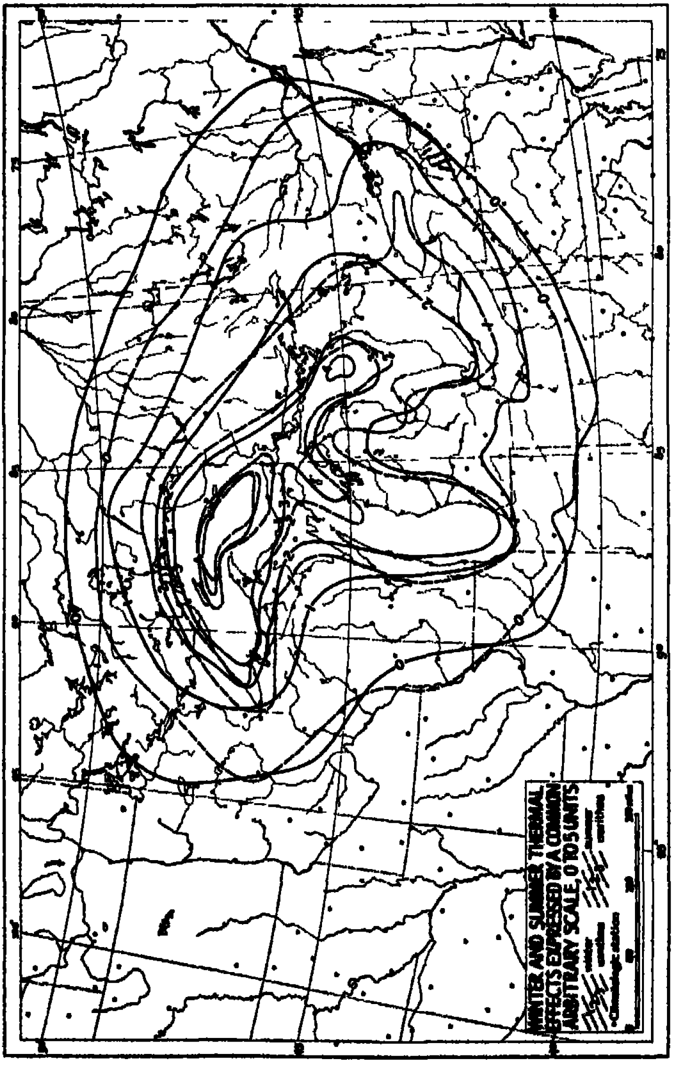
WINTER AND SUMMER THERMAL EFFECTS EXPRESSED BY A COMMON ARBITRARY SCALE, 0 TO 5 UNITS

FIG 15

by the presence of fog, so that air arriving over the lakes from above the warmer land surfaces is cooled more over the foggy lakes than above those farther south At the maximum, according to Figure 2 the decrease in temperature above the lakes from the southern end of Lake Michigan northward to the middle of Lake Superior is roughly twice that over the lands in the same latitude farther west According to Figure 10, the effect of the complex of factors associated with the lakes on the delay of the maximum is markedly greater than on the actual temperatures at the maximum The temperatures attained at the maximum are determined by the extent to which air from above the lands is cooled by the surface of the water This amount in turn depends upon the difference in temperature between air and water and on the intensity of turbulence in the lower layers of air The difference between Lake Superior and the lower lakes in these regards must be only moderate, and only a moderate difference between them appears in Figure 9 The process of cooling the air involves adding to the curve of effective insolation a curve of heat transfer such as S' in Figure 17 C–D Where there is little fog this curve of heat transfer is added to an insolation curve having a rather sharp peak, such as I_3 Over a foggy surface the same curve of heat transfer is added to an insolation curve flattened to some such shape as that of I_4 It will be noted that, given comparable curves of heat transfer, the date of the extreme is strongly affected by a change in the shape of the insolation curve The difference in relative effect of Lake Superior fog on temperature at the maximum and on delay of the maximum after the summer solstice may be confidently ascribed to such a difference in shape of the insolation curve as is embodied in curves I_3 and I_4 of Figure 17 The difference in delay of the maximum between Lake Superior and the lower lakes is therefore such a difference in delay as between Q'_4 and Q'_3 in Figure 17

Over the land in general the rate of fall of temperature in autumn (Fig 4) increases steadily toward the extreme interior of the continent — toward the northwest within the area covered by the maps used here The same regional increase in rate of fall appears about the lakes, but is there less rapid The water is warmer than the air in autumn, but the difference between the temperatures of air and water is somewhat less than in spring. The resulting instability of the air near the water surface favors turbulence and free exchange of

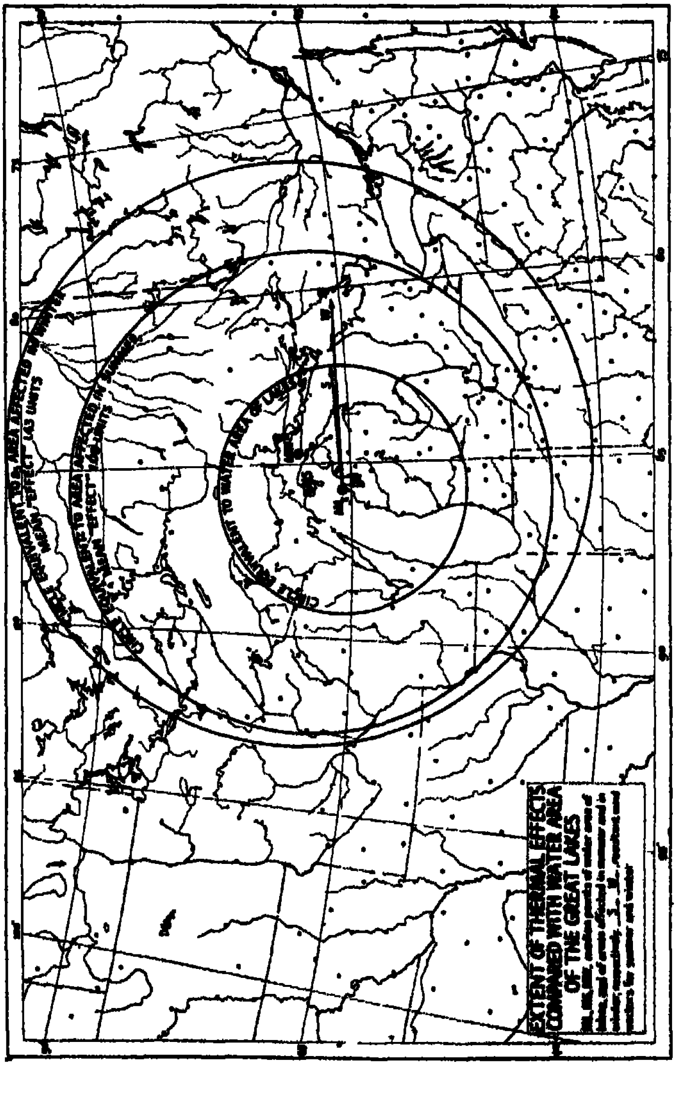
EXTENT OF THERMAL EFFECTS
COMPARED WITH WATER AREA
OF THE GREAT LAKES

FIG 16

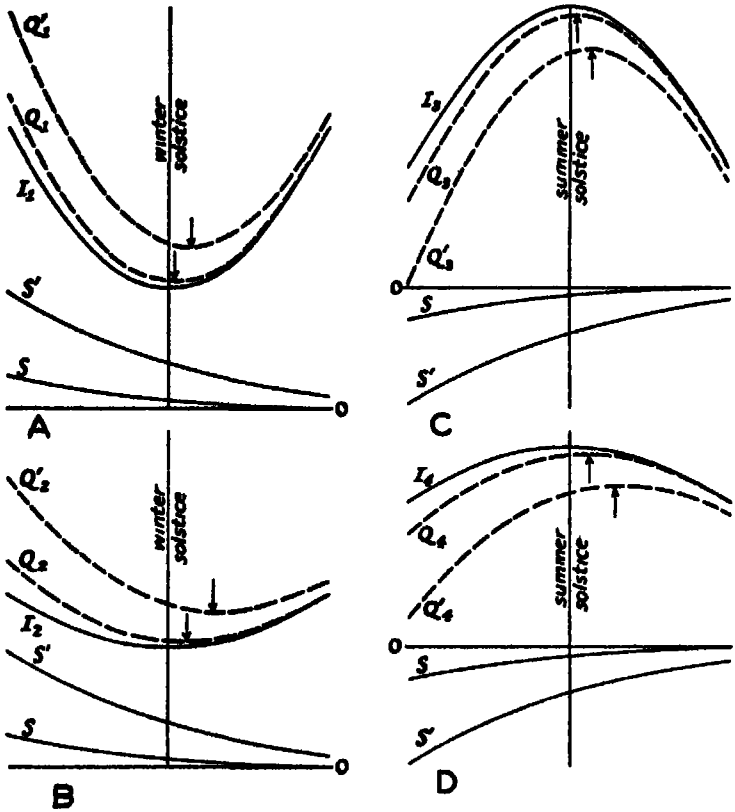

FIG 17 Curves of total heat supply to terrestrial surfaces, and their components· A–B, at minimum of the annual march, C–D, at maximum I_1, I_2, I_3, and I_4, curves of effective insolation, S and S', curves of heat transfer Q_1, Q_2, Q_3, and Q_4, curves of total heat supply, the sums of the respective curves of effective insolation and S, Q'_1, Q'_2, Q'_3, and Q'_4, the sums of the respective curves of effective insolation and S'

heat between water and air Considering that the air temperatures prevailing in the latitude of Lake Superior are lower than those farther south, and also that the difference in temperature between water and air over the northern lake surfaces is greater than it is farther south, the relative effects of Lake Superior and of the lower lakes recorded in Figure 11 cannot be looked upon as at all abnormal

The same generalization may be made concerning the effects mapped in Figures 12 13 These maps record something close to a pure effect of interchange of heat between air and active surface, complicated by no factor such as confuses the influence exerted by the lake surfaces in summer A comparison of Figures 9 and 12 shows that the air over the lakes is warmed by them at the minimum by about twice as much as it is cooled in summer I do not have access to comparable observations of winter and summer temperatures of lake surfaces and air, on which a judgment concerning the reasons for this seasonal difference might be drawn One factor, however, differs strongly between summer and winter, and in such a manner as favors a more active transfer of heat from water to air in winter than from air to water in summer This factor is the instability of the air immediately above the water surface induced by warming in winter, which favors very free convective mixing, hence free transfer of heat upward into the air from the water surface Free convective mixing is easily visible in the "steaming" of the open lake surfaces into cold air in winter In summer, on the contrary, cooling of the air close to the water surfaces renders it highly stable, and so hinders free mixing One result of this circumstance would be that the temperature gradient from air to water in summer would be steep, and concentrated in the layer of air close to the surface of the water, whereas in winter the gradient from water to air would be less steep, and so extend to a greater height In winter the effect of the lake surface on the temperature of the air might therefore be more evident than in summer at stations on the neighboring land

In the foregoing paragraphs the discussion has been mainly concerned with air above the surface of the lakes rather than above the surrounding lands Interpretation of the influence of the lakes on the march of temperature in the air above these lands may proceed from Figure 17 A and C Both in summer and in winter the curves of effective insolation have moderately sharp extremes In horizontal turbulent exchange of air between land and lake, relatively warm air flows from lake to land in winter, relatively cool air in summer In winter, therefore, the climatologic air at a land station receives an increment of allochthonous heat from the lake in addition to its autochthonous heat derived from local insolation The amount of that increment decreases with increasing distance from its source The sense of the change with increasing distance from the lake is

represented by a change, say, from curve S' in Figure 17A to curve S, and the corresponding change in the march of temperature is in the same sense as the change from Q'_1 to Q_1 In summer a part of the local supply of heat derived from insolation goes to warm cool air from over the lake, so that the maximum is lower than it would be if the surface within the field of wind fetch consisted entirely of land With increasing distance from the lake the amount of heat thus disposed of decreases, in a manner represented by a transition from S' to S in Figure 17C, and the temperature curves correspondingly shift in such a sense as from Q'_3 to Q_3 Except in the immediate vicinity of the lakes, where lake fogs may affect insolation, the thermal influences of the lakes at the maximum may be taken as approximating the effect of pure heat transfer uncomplicated by any indirect effects

A comparison of the total effects in winter and summer represented in Figure 15 shows that the thermal influences of the lakes are not so widely distributed over the adjacent land in summer as in winter, but are more sharply concentrated over the lake surfaces This fact is probably not wholly the consequence of the perturbation of the normal process of heat transfer between lake surface and air by the summer fogs of the northern lakes The circulation of air is much more active in winter than in summer, and with the generally greater stability of the air (as contrasted with the instability of the air near the water surface) the horizontal components of turbulence in the air probably have a larger ratio to the vertical components than in summer The same amount of heat is released in winter as is accumulated in summer, so that if a measure of the total thermal effect in three dimensions could be obtained the summer effect should be equal to the winter effect The vertical dimension of the three-dimensional field of effect must therefore be larger in summer than in winter

The generalizations of areas affected and their relation to the lakes, represented in Figure 16, are likewise comprehensible The areas of the circles indicating them are the areas within the isarithms of zero effect in Figure 15 The area affected in winter is 5 5 times the water area of the lakes, that affected in summer 4 7 times their area The total measurable effect of the lakes in winter, according to the procedure of estimation used (product of area affected times mean effect) exceeds their effect in summer by 55 per cent Because

of the secondary influence of fog over the northern lakes in summer, the two quantities are not strictly comparable, yet even that indirect influence is also an effect of the lakes It has therefore seemed worth while to include it (since it is impossible to eliminate it from the data) in this final generalisation

The present discussion, concerned with the general problem of the rôle of the Great Lakes in the heat economy of the atmosphere above and near them, has necessarily dealt with the most general qualities of the annual march of temperature There are undoubtedly other climatic elements, including some of immediate practical importance, that would yield to the cartographic procedure used here, and from the distribution of which interesting conclusions might be drawn I think, for example, of average maximum and minimum temperatures at the extremes of the annual march, of maximum and minimum temperatures at times that are critical in relation to certain crops, and on days to which some particular interest may attach, and of precipitation, either means or actual measured values during specific periods or individual storms In all these climatic phenomena, and in others that may occur to the reader, it should be possible to dissect out the effect of the lakes, and so make more precise the rather indefinite impressions that at present are the only available basis for statements concerning their climatic influence

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SETTLEMENT PATTERN OF THE WESTERN HIGHLAND RIM PLATEAU OF TENNESSEE *

H. THOMPSON STRAW

THE Western Highland Rim Plateau of Tennessee is the upland area lying between the Central Basin and the Coastal Plain portion of the state (Fig. 1). This upland area is a part of the Interior Low Plateau province. Its summit level is mainly a remnant of the peneplain developed over the middle third of the state during Tertiary times,[1] a peneplain subsequently to be uplifted and dissected by stream action and to some extent by solution. Although sinkholes are found throughout most of the region, they occur in greater numbers in the north and become increasingly less frequent as one proceeds southward, where the rock strata are less soluble. In general, then, river cutting far exceeds karst development in determining present-day landforms.

Today in many places the plateau character of this region is not readily discernible. Rather the land seems to consist of youthful, flat-topped ridges interspersed with river valleys, the larger of which are in maturity, with well-developed valley flats. The distribution of these ridges and valleys may be seen in the physiographic diagram (Fig. 2). It can be noted that the Duck River forms a rough dividing line in that part of the region lying east of the Tennessee River. North of the Duck River the surface is gently rolling, much of the plateau level is still discernible, and the main river valleys tend to be narrower than in the south. The part of the region south of the Duck River has been deeply cut by the streams. Flat ridge-top areas are still numerous, but are broken by

* The author wishes to acknowledge his indebtedness to the Social Science Research Council of New York for a grant-in-aid for field work which made this paper possible.

[1] For a detailed study of the geologic history and strata involved see Bassler, R. S., *The Stratigraphy of the Central Basin of Tennessee*, Bull. 38, especially pp. 3–162. Nashville, Tenn.: Division of Geology, 1932.

wide river valleys, the floors of which are covered with sand and silt[2] The difference in surface, however, is not of great degree Nowhere in the region is one far from a flat-topped interfluve or a silt-filled river basin It is this combination of surface which constitutes the terrain

The agricultural settlement of the region was accomplished in the early part of the nineteenth century by the middle-class yeoman farmers Many moved from the earlier-settled Nashville Basin, with its better transportation facilities, in order to escape the increasing competition of the planter class[3] With the opportunity of establishing themselves on the flat land of the ridge tops or on that of the valley bottoms, they chose the latter, with its richer soil of recent alluvium and the somewhat better transportation provided by the

FIG 1 Surface map of Tennessee, showing location of Western Highland Rim Plateau

use of crude rafts and boats on the larger streams In all the county units within the region there is only one that is possibly an exception to the general rule of early valley settlements, and that exception is dubious because the records do not definitely specify a location[4]

[2] In detail the distribution of soil and surface features within the valleys is more complicated A succession of uplifts in late Tertiary and Pleistocene times has resulted in a series of none too sharply defined valley terraces, the older of which generally are composed of gravel, although the present flood plains are usually silts and clays See Jewell, W B, *Geology and Mineral Resources of Hardin County, Tennessee*, Bull 37, especially pp 14–17, 18–19, 49–50 Nashville, Tenn.· Division of Geology, 1931

[3] Abernethy, T P, *From Frontier to Plantation in Tennessee A Study in Frontier Democracy*, p 209 Chapel Hill, N C Univ of North Carolina Press, 1932 See also Spellings, W W, "The Spread of Population in Tennessee," M A thesis, George Peabody College for Teachers, Nashville, Tenn, n. d (*in manuscript*), and *Preliminary Population Report*, Sec 1A, maps 3–4 Nashville, Tenn Tennessee State Planning Commission, 1935

[4] For a convenient check list of early settlements see Allred, C E, Watkins, S W, and Hatfield, G H, *Tennessee, Economic and Social*, Part II, "The

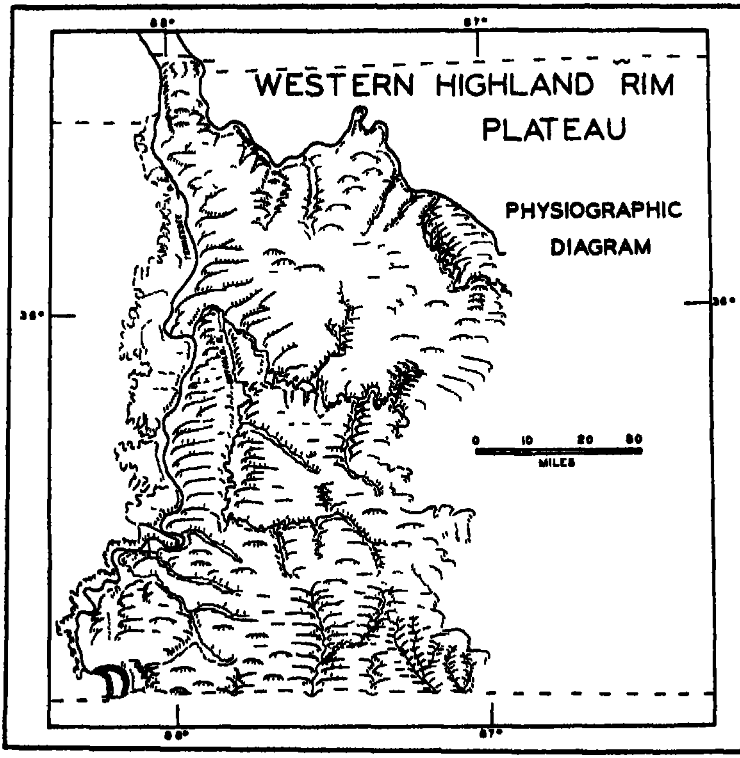

FIG 2

Note that more of the original plateau surface is preserved north of the Duck River than south, where the river valleys tend to be wider

In these valley settlements a pioneer economy was to be maintained long after it had disappeared from the adjacent lowland areas, such as the Nashville Basin

Similarly, the development of the mineral industries within the region was to concentrate in the valleys rather than on the ridge tops. The two minerals of greatest importance were iron ore and phosphate rock. The iron ore occurs in the form of limonite and in

Counties," pp 6–7. University of Tennessee Record, Ext Series, Vol II, No. 3 1920.

many places is associated with the St Louis limestone which caps the ridge top[5] Since it requires washing before smelting, however, the plants and related settlements were generally to be found in the valleys, where water supplied by the streams was available The smelting plant at Cumberland City was typical of this development (Pl I, Fig 1) It was one of the first to be established and one of the last to close Ore was supplied from the near-by hilltops, and charcoal was produced from the forests of the neighboring slopes As can be seen from the illustration, the industry was always a small one, but since there were about thirty-five similar plants in the region at the time of the Civil War they were important in determining settlement location during the early days Today, however, only two of the furnaces are in operation

Later the mining of phosphate rock likewise tended to augment the valley settlements Most of the phosphate is of the blue variety, is restricted to the southern half of the region, and is associated with rock of Devonian age, which occurs considerably below the ridge top capped with Mississippian strata[6] Therefore valley sites were utilized in its extraction Like that of limonite, the production of blue rock has ceased owing to outside competition, in this instance from the brown phosphate of the Nashville Basin

Today most of the settlements are still in the valleys Figure 3 illustrates the all-too-common situation — settlement pushed into this area from the Nashville Basin by way of the Duck River Valley, a section of which may be seen in the northeast part of the map Land was cleared along Beaverdam Creek and then along the various tributary creeks which dissect the area It should be noted that not one of the wooded hills bears a name, whereas most of the creek valleys, if wide enough to accommodate any cleared land, are named, in many instances in honor of one of the first settlers in that particular area At the present time, with only one small exception, cleared land is restricted to these creek bottoms, although the interfluves which are flat-topped would offer approximately the same amount of level land for clearing Indeed, only about three miles south of the area under discussion, on a terrain not particu-

[5] Burchard, Ernest F, *The Brown Iron Ores of the Western Highland Rim, Tennessee*, Bull 39, pp 24–37. Nashville, Tenn.: Division of Geology, 1934

[6] Straw, H Thompson, "Phosphate Lands of Tennessee," *Ec Geog*, 17 (1941) 93–104, especially pp 95–96

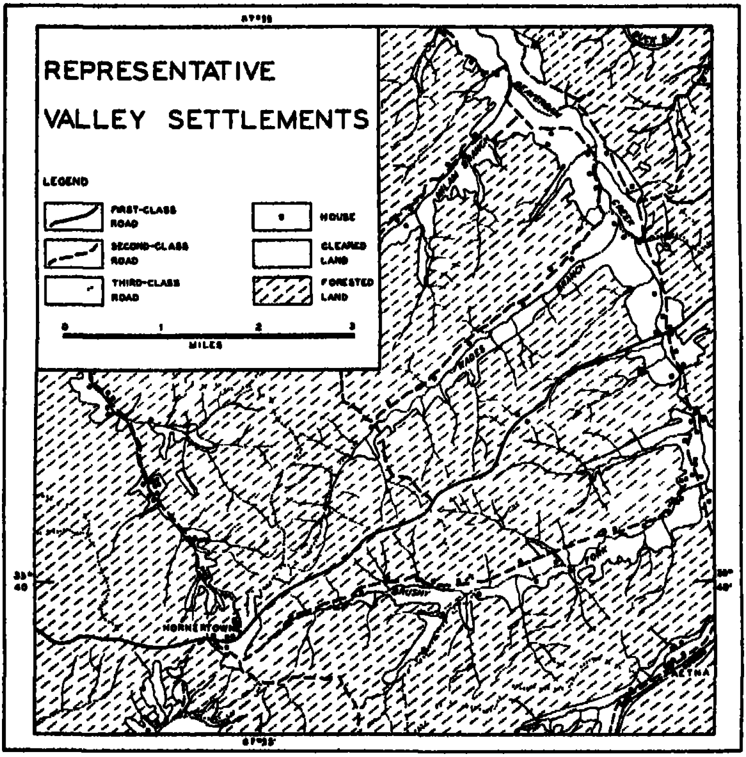

FIG 3

Note that the valley settlements are separated from the main roads by steep valley slopes

larly different, the settlements of the German Swiss (which will be mentioned later) have been located on the ridge tops Most of the cleared land of the creek bottoms is devoted to corn, hay, and pasture. There are almost no cash crops, and nearly all of the forage crops are fed to animals, some of which are sold from the farms and constitute, with timber from the near-by hills, the major source of income, which is small at best The majority of these farmers own their farms and appear to carry on agriculture at or near the subsistence level

About 1846 an iron furnace was erected at Aetna, shown in the southeast part of the map (Fig 3) The ore was obtained from the hilltops north and west of the village The washer was on the lower slope, and the blast furnace and charcoal ovens were in the valley At one time about four hundred persons were employed here,[7] and the village had some fifty houses located near the plant Today the plant is dismantled, and the site is marked by a single store, a railroad siding, and fewer than a dozen houses But while the industry operated it augmented the valley settlement pattern, established earlier by agricultural clearings

The one ridge-top community in the whole area is Hornertown It is of fairly recent origin and owes its existence largely to the convergence of routes leading from the valley settlements to the main road

The disadvantages of location in the valley were brought into sharp relief by the improvement of the main or first-class roads These main roads have tended to cling to the flat ridge tops, since they were designed not to serve the region but to cross it The general picture has been all too often that of a main road flanked on either side by unbroken forest, with the valley settlement isolated from it (Pl I, Fig 2), the only connection being an unsurfaced secondary road which traverses the steep incline of the valley side Since such roads are impassable during the winter or immediately following a rain, this situation has meant difficulty in marketing produce and resultant low standards of living, which have in turn led to large relief loads and low tax returns for the state Valley settlements have likewise tended to preclude the easy expansion of farmland and cropland In the small valleys, such as that shown in Plate I, Figure 3, the area available for crops on the valley floor is insufficient The adjacent lower slope in the background, which, naturally, was cleared after the valley bottom had been, is so steep that soil erosion has ruined the land even for pasture, and it is in the process of being reclaimed by the forest Thus many attempts to add to the improved land and so augment the individual farm income are checked

Ridge-top settlements are largely confined to the eastern part of the region (Fig. 4) Two factors have been of prime importance in establishing this pattern of settlement, which differs so radically

[7] Burchard, *op cit.*, p 99

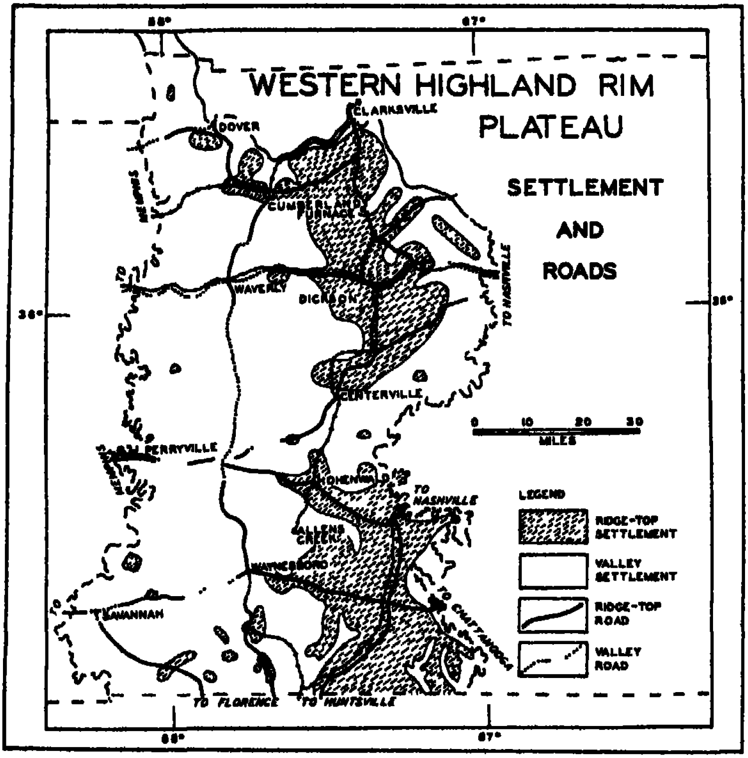

Fig 4

Ridge-top settlements are largely restricted to areas which produce commercial crops, cotton in the south and tobacco in the north Note the presence of ridge-top roads, which must serve valley settlements

from the earlier one They are the development of cash crops — dark-fired tobacco in the north and cotton in the south — and the colonizing practices of the German Swiss within the region Both cash crops can be grown on the valley floors, but most of the farmers seem to prefer the upland soils In the cotton-growing southern section they fear that the valley soils will be slow to warm up in the spring and thus will shorten the growing season, which is not too long at best In the north the farmers believe that it is easier to

produce on the upland soils the heavy-bodied tobacco demanded by the Clarksville market The more fertile valley soils tend to yield plants of more luxuriant foliage, which require more frequent topping It is interesting to note that when Burley tobacco is grown the valley site is generally used The German-Swiss settlers were most numerous around Hohenwald They were established by land agents on ridge-top land which was purchased because it was cheap Many of these settlers have now migrated, but they have left a few of their descendants, distinctive place names, and a rectangular road pattern, similar to that of the Northwest Territory The description of land titles here, also, is essentially a modification of the range-and-township system of survey

Most of the region still remains an area of valley settlement Cash crops are absent, and corn occupies most of the cropland The isolated areas of ridge-top settlement generally mark the location of a convergence of secondary roads on the main highway, and here local commercial centers are usually found It will be noted that the pattern of ridge-top settlements is obviously somewhat related to the pattern of ridge-top roads, since they tend to develop farthest along these roads However, ridge-top roads do not necessarily mean ridge-top settlements Rather they seem to develop as the result of specific cash crops or a historical accident, such as the settlement of the German Swiss

In attempting to arrive at any solution of the problems which arise from the land use of the region, this pattern of settlement must be one of the basic factors considered Not only must the condition of surface and soil and the possibilities of forest and mineral exploitation be taken into account, but the existence of this pattern and its relation to roads, established schools, and other public services, together with those which may be planned for the future, must also be studied

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FIG 1 Smelting plant at Cumberland City One of the numerous small charcoal furnaces which were present in this region

FIG 2 Ridge-top road through unbroken forest land Most of the settlements are in valley bottoms, separated from the main road by steep valley sides

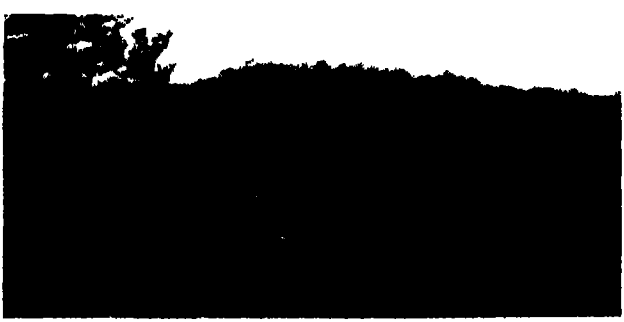

FIG 3 Valley settlement, with pasture in the foreground and corn along the stream in the middle distance In the background the lower valley slopes have been cleared and planted, but erosion has led to their abandonment, and they are now being allowed to return to forest land

THE RURAL ZONING PLAN OF MARQUETTE COUNTY, MICHIGAN *

JOSEPH VAN RIPER

IT IS the purpose of this paper on the rural zoning plan of Marquette County, Michigan, to present some of the problems facing the land-use planners in the northern counties of the Lake states These problems do not concern simply adjustments to the quality of the land, but involve also a wide variety of social, economic, and geographic factors

Rural zoning has been in practice for some years in different areas of the United States, on December 30, 1938, however, Marquette County, located in the north-central part of the Upper Peninsula of Michigan (Fig 1), became the first county in this state to place in operation a rural zoning ordinance (Fig 2) The plan itself is simple it merely prohibits agricultural settlement in areas not now serviced by roads and schools, but the forces motivating it are of particular interest to geographers [1]

PHYSICAL BACKGROUND

A quick glance at the physical background of Marquette County reveals at once that, like many regions in the northern part of the United States, it has wide areas within it unsuited to agriculture Figure 3 shows a division of the county into areas in which the surface conditions are more or less homogeneous The sand plains indicated here are typical scrubby sterile jack-pine barrens (Pl I, Fig. 1) The hard-rock knob district, consisting of crystalline knobs from one hundred to three hundred feet high, which are separated by innumerable lakes and spruce swamps, is a characteristic section of Laurentian upland Only occasionally is there a small patch of

* This article is a condensation of a thesis submitted in partial fulfillment of the requirements for the degree of doctor of philosophy at the University of Michigan.

[1] It must be clearly stated that the promotion of the zoning plan was at all times carried on by residents of the county

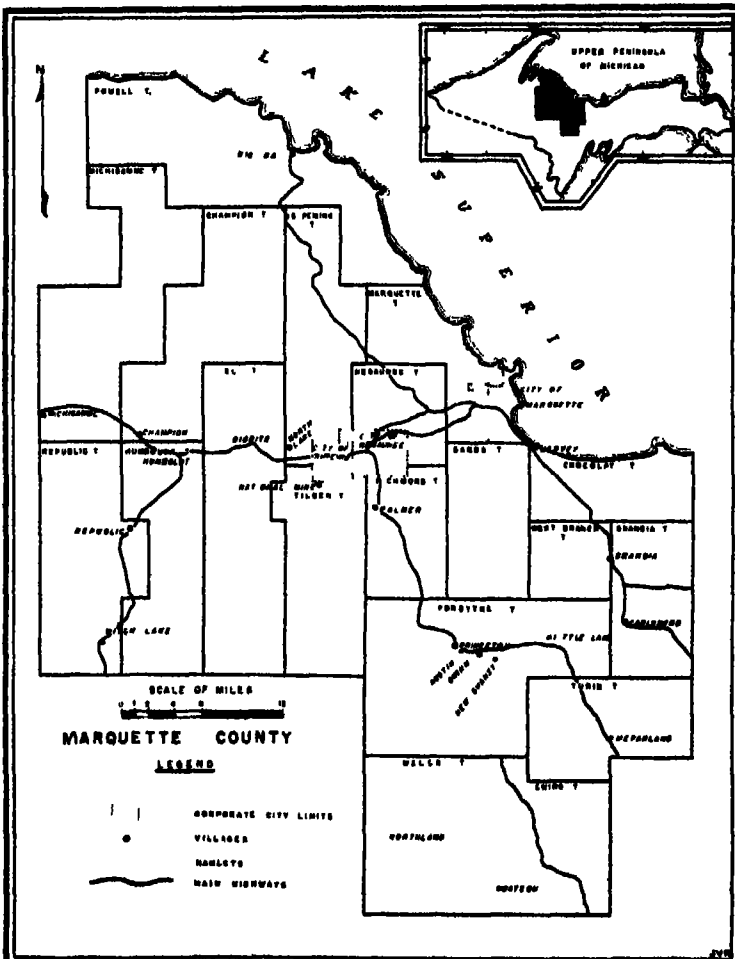

FIG. 1

moraine free enough of boulders for cultivation. Both the sandstone uplands and the Lake Superior borderland have wide stretches of thin sandy soils and long slopes, which are not suitable for farming Only two of the largest poorly drained areas are shown here, but fully

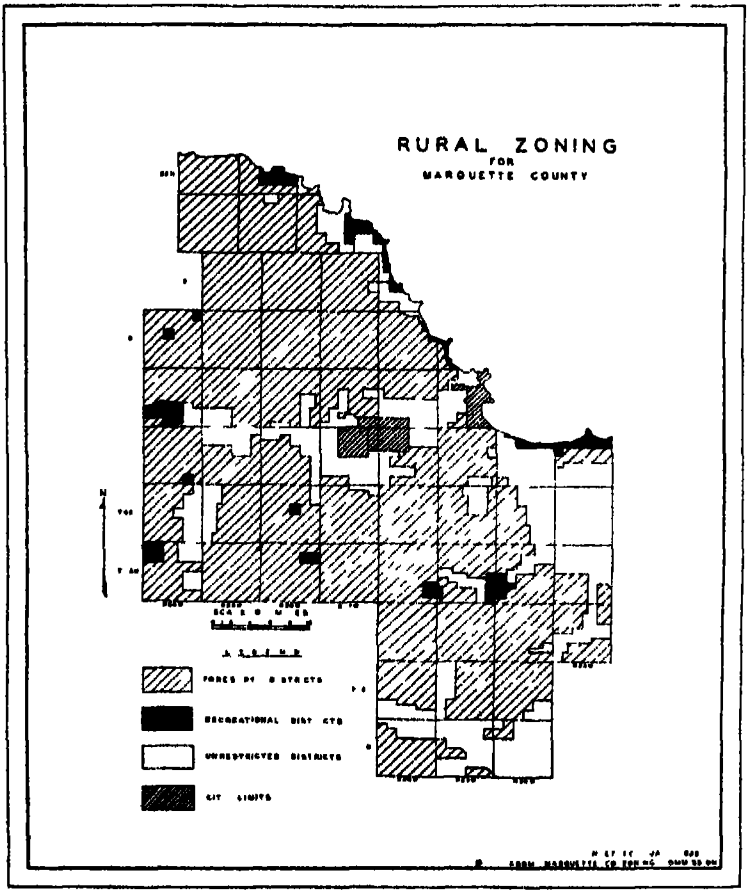

Fig. 2

one fourth of the county is covered by lakes and swamps, most of them small. Nowhere is there any extensive continuous area of superior soils The Amasa rolling uplands, characterized by moraines, kames, and drumlins, is but slightly above average in the quality of its soil, and its development is hindered by its remoteness from markets and by a short growing season The Marquette iron range,

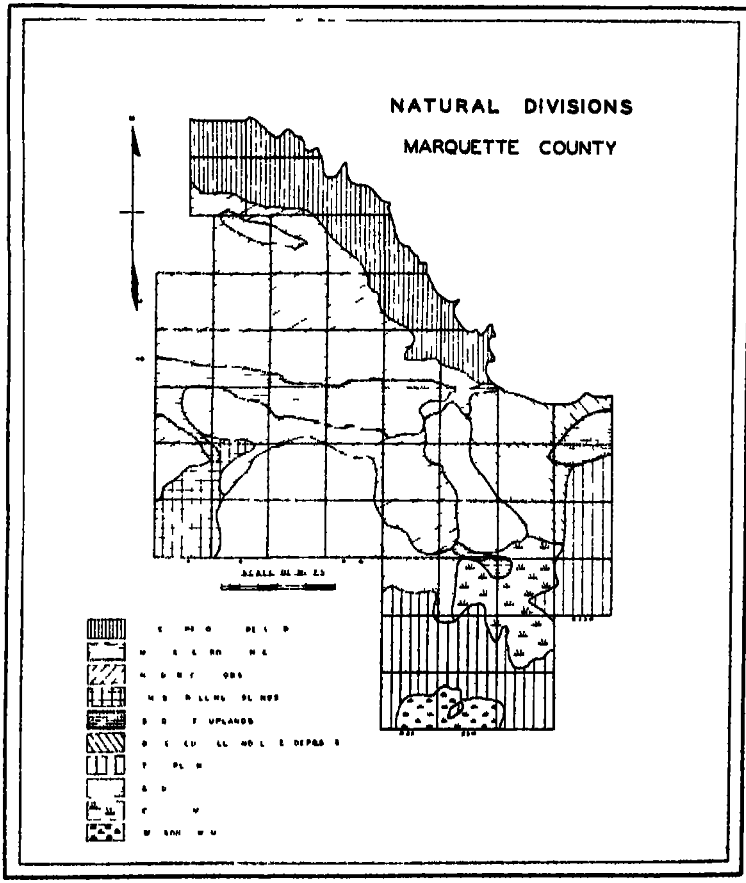

FIG 3

with its less pronounced relief, glacial gravels, loose slate outcrops, and accessible markets, ranks next to the dissected till and lake deposits region in the number of successful farms The latter region has the best soil and the smallest percentage of swampland of any part of the county, and has a further advantage in its nearness to the mining centers In terms of agriculture, fully three fourths of the county is distinctly submarginal (Fig 4)

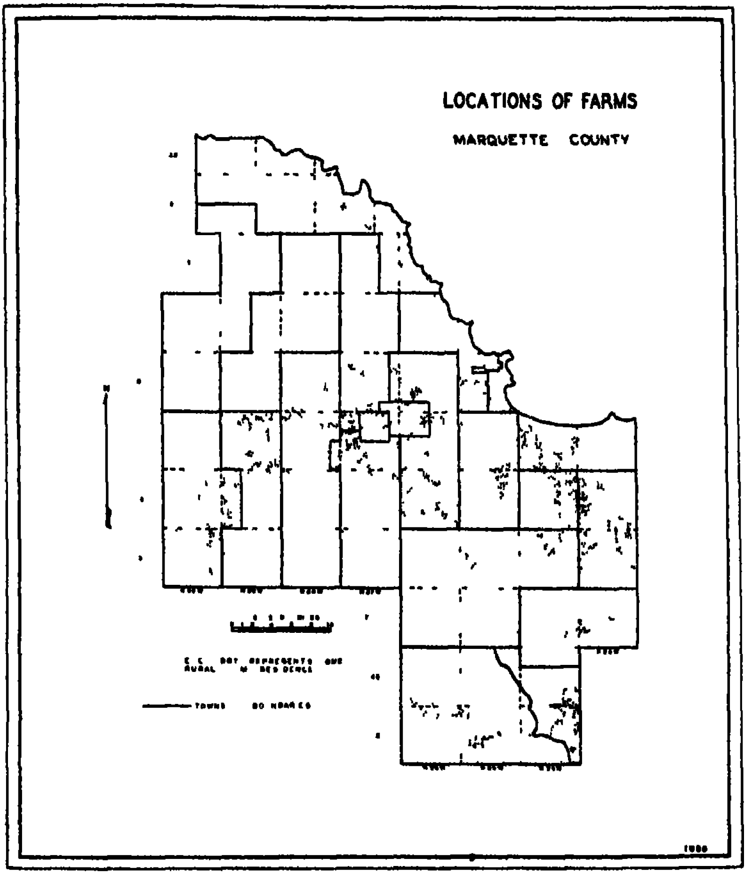

FIG 4

Lumbering is carried on at present only in small-scale operations, and is based on motor trucking It has little significance for permanent settlement, since the best and most readily available timber and wood products have already been removed White pine, red pine, and hemlock were the first trees to be extensively exploited Today only a few small stands of these trees of saw-timber size remain, and those only in the most inaccessible regions (Pl. I, Fig 2)

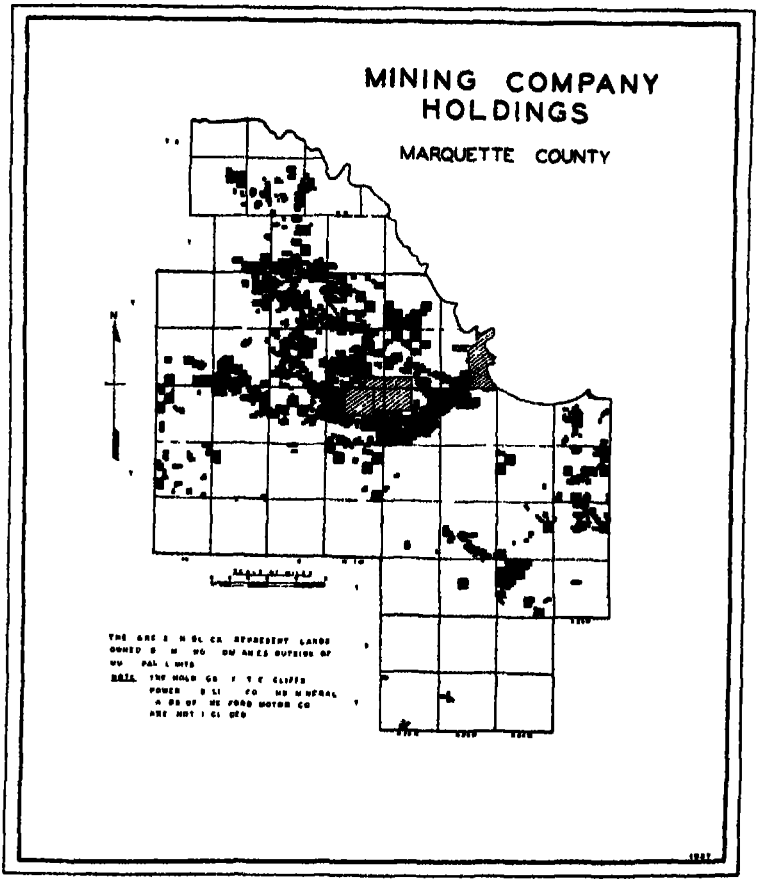

FIG 5

During recent years forest operations have consisted in cutting the upland hardwoods and the swamp conifers. The former supply lumber for the automobile industry and for furniture, flooring, and other interior trim The swamp conifers are utilised mainly for pulpwood, posts, railroad ties, and mine props (Pl I, Fig 3). During recent years much of the less desirable hardwood has been used in distilling or for firewood.

Large stands of merchantable hardwood remain in only a few localities in the county, mostly in the northwestern part. Pulpwood extraction has been moving northward in the county during the past few years. Most of the swamps in the southern part have been cut over, and although cutting for pulp is still being done in this area the reserves are rapidly being depleted. The largest ones remain in the small swamps in the hard-rock knob district.

The principal industry in the county is the mining of iron ore, mostly hematite, which is found within the Marquette iron range (Fig. 5). The chief iron-bearing formation outcrops in an area approximately five miles wide in the vicinity of Negaunee and Ishpeming. West of this area the formation is deeply buried in the center and comes to the surface in a north and a south limb. The narrowness and the steeply dipping character of most of the iron-ore deposits throughout the county are not advantageous to large open-pit mining (Pl. II, Fig. 1), and, except in a few localities, underground shaft mining is the rule. In 1938 the county's mining industry employed 2,775 persons.

THE HISTORY OF SETTLEMENT AND ITS EFFECTS ON THE ZONING PROBLEM

The focus of settlement in Marquette County since the coming of the first white inhabitants has been the area containing iron reserves, where mining brought about the development of scattered large and small urban centers. Rural settlements at first were located near these urban centers and consisted of both farm and woodworking communities. The latter supplied lumber to the rapidly growing cities and towns or hardwood for the kilns which furnished charcoal to local pig-iron furnaces prior to the development of cheap transportation of ore to the lower Great Lake ports. Nearly all the few farming communities outside the iron district were situated in the areas of better soil and of slightly longer growing season in the eastern and southeastern parts of the county. According to some of the older inhabitants, these early farmers had no difficulty in selling their hay, oats, and potatoes in the urban markets. There were few dairy farms as we know them today, and part-time farms were located only in the immediate environs of the mining towns. No improved roads existed at this time, and there were few rural schools, but the people on the farms made a good living, for prices of agricul-

tural produce were high because of the constant pressure of population in the urban centers

The last two decades in the nineteenth century brought several events which were to have serious consequences in later years The first of these was the absorption of the small mining concerns operating tiny open-pit mines with little capital This absorption was the result of (1) the exhaustion of the surface deposits and the consequent necessity of using expensive underground mining methods and (2) the economic depression of the early nineties, which, with its attendant low prices, wiped out many small operators. A second event was the decline in the demand for mine labor, which came about because of competition from the new Mesabi open-pit operations in Minnesota and because of the change from hand tools to machinery A temporary boom in local mine employment was experienced during the war years of 1914–18, but it did little to check the steady decrease both of mine employment and population in the urban centers People living in the mining communities had either to turn to new occupations or to go elsewhere Some of them moved to the new mining regions in the Rocky Mountain area Many of them went into the rural sections of the county, hoping either to practice part-time farming and to supplement their income by periodic mine employment or to make a living from farming alone The number of farms greatly increased between 1890 and 1920

This settlement of the rural districts was made chiefly by Finnish immigrants An examination of the county directories of 1870 and 1880 does not reveal a single Finnish name Only a few are given in the 1890 directory, but the 1901 edition lists a large number. Many of the earliest Finns to arrive in this country went to the mining region of northern Michigan, and, although they had not been miners in the old country, they found mining lucrative and easy to learn After a brief experience with crowded boardinghouses and after rather violent social contacts with Cornish, Irish, and French-Canadian miners, the Finns took up small plots of land near the mines These "farms" generally consisted at first of from ten to fifty acres, one or two cows, a horse, and a pig. The cropland supported little else than a house garden, a patch of potatoes, and a small field of oats, with the remainder devoted to hay The buildings were log cabins (usually whitewashed). a hut for living quarters, a small "crib" barn, and a "sauna" or steam bath Sometimes the

farmer worked in the mines during the winter and on his farm during the summer, or, if his family was large enough and work was available, he worked full time in the mines, the farm work being done by his family

Since they were relatively late-comers in the farming districts and since they had little money with which to purchase land the Finns went into the poorer areas and, with the exception principally of Ewing Township, where lumbering formerly supplied a cash income, and of an area near Skandia, they settled lands that were adjacent to the mining districts Today most of the poor, part-time farms are owned by Finns, the better farms being held by Swedes, Germans, or French-Canadians (Pl II, Fig 2, Pl III, Fig 1) Within the county, then, one of the most significant problems of submarginal settlement resolves itself into a social question, dominated largely by the degree of adjustment which the Finnish people have made to the land and to a new standard of living and complicated by the fact that the second-generation Finns have refused to be content with the low standard of living of their parents

PRESENT ECONOMIC OPPORTUNITIES FOR RURAL SETTLEMENT

Settlement in the rural districts of Marquette County, if it is to maintain itself on the land, must in general depend upon the following types of livelihood agriculture, forestry, mining, the provision of recreational facilities, or combinations of these

The potentialities of the land for supporting settlement by agriculture alone are slight even in the best farming areas The most vital factor is climate, although a soil suited to potato cultivation is also important, as well as the farmer's ability to produce and market dairy products and potatoes Most of the successful dairy farms are located near the three cities Ishpeming, Negaunee, and Marquette On farms remote from these cities the only dairy product that yields cash dividends is cream, which, because of its relatively high value and low bulk, is able to bear the transportation charges A farm that depends entirely upon farm income for its support has to be exceptionally well situated and well managed (Pl III, Fig 2)

Part-time farming has as its basic economy an association with mining or lumbering In general, the location of part-time farms is more closely related to the mines or to the timber supply than to land favorable for agriculture. For this reason the concentration of

such farms is near the central part of the county. Nearly all the farms in Humboldt Township are of this type, their operators originally depended upon mining for their cash income, but now depend upon public welfare These small farms are located within the hard-rock knob region, on ground that should never have been cultivated, for soil and climatic factors are particularly adverse Under present conditions successful part-time farming can undergo very little expansion in the uninhabited parts of the county because of (1) a decrease in mine employment, (2) the too-great distance to mines still operating, and (3) a depletion of wood reserves

Forestry as an industry supporting rural settlement is well on the decline, and stranded families of forest workers can be found here and there in the cutover parts of the county

The recreation industry has, as in other parts of the United States, been responsible for an appreciable growth in local incomes even in the rural areas, but away from the main highways it has not been capable of supporting an increase of rural settlement.

Because of the uncertain character of mine labor few rural families depend entirely upon this occupation for their livelihood Most of them supplement it with farming or lumbering or by providing for vacationists

GOVERNMENTAL EXPENDITURES IN RURAL AREAS

The year 1915, approximately, marked the beginning of extensive public expenditures for roads and schools in the county In every township the tax rate rose rapidly after this date, reached a peak in 1930, and fell sharply between 1932 and 1934,[2] a decline resulting from a 15-mill property-tax limitation passed by the state legislature in 1933

Only a small part of the local tax burden is borne by the resident taxpayers. A study of tax-assessment rolls in five townships was made for the purpose of distinguishing between the property of residents and nonresidents These five townships were Humboldt, West Branch, Ewing, Champion, and Turin, which represent very different combinations of physical and cultural environments Tables I and II show the valuation and taxes levied on the property of residents and nonresidents, the tax delinquency on the part of resident property owners, and the total valuation, taxes, and tax delinquency in these

[2] See *Annual Reports of the Marquette County Board of Supervisors*, 1912–37.

TABLE I

VALUATION AND TAXES LEVIED ON PROPERTY OF RESIDENTS AND NONRESIDENTS AND TOTAL VALUATION AND TAXES LEVIED FOR 1937 IN FIVE TOWNSHIPS IN MARQUETTE COUNTY *

Township	Total valuation	Valuation on property of residents	Valuation on property of nonresidents	Total taxes	Taxes on property of residents	Taxes on property of nonresidents
Humboldt	$ 460,425	$68,750	$391,675	$ 7,046 86	$1,059 70	$ 5,987 16
West Branch	267,300	69,600	197,700	4,097 71	1,080 88	3,016 83
Ewing	107,840	31,830	76,010	2,403 98	728 60	1,675 38
Champion	1,033,780	33,840	999,940	23,635 20	771 03	22,864 17
Turin	289,250	18,575	270,675	7,663 26	516 63	7,146 63

* Data from township assessment rolls

TABLE II

TAX DELINQUENCY ON PROPERTY OWNED BY RESIDENTS AND TOTAL TAX DELINQUENCY FOR 1937 IN FIVE TOWNSHIPS IN MARQUETTE COUNTY

Township	Taxes levied on property of residents	Percentage of property of residents delinquent	Total delinquency, in percentage *	Average value per acre of real property of residents
Humboldt	$868 15	18 08	46 83	$4 48
West Branch	777 34	28 08	18 99	9 58
Ewing	532 74	26 88	58 94	4 70
Champion	771 03	0	8 81	7 43
Turin	361 00	30 09	45 41	6 84

* Data from county treasurer's office

townships for 1937 From this material the following conclusions are drawn (1) The percentage of property owned by residents is low in all townships, but lowest in those that contain mineral lands and highest in the better farming districts; (2) The average value per acre of real property belonging to residents is low in all parts of the county; (3) Delinquency of taxes is highest in the nonmining areas (see Fig 6)

Until the passage of the 15-mill tax-limitation bill in 1933 there

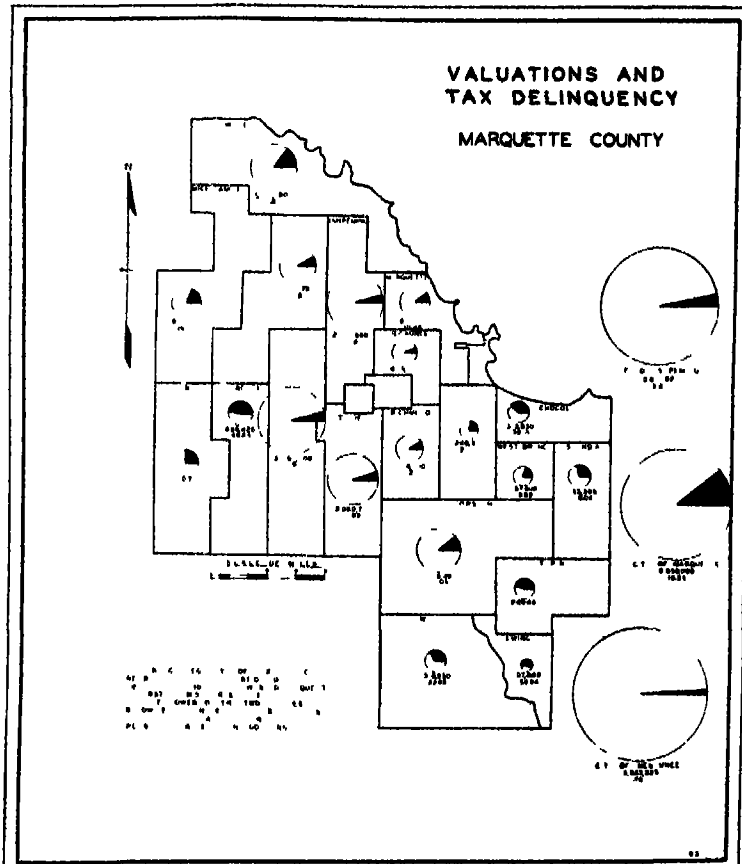

FIG. 6

was practically no limit to the amount of money that could be raised for public expenditures Even now, the 15-mill limitation can be amended by a two-thirds vote within the townships Thus, with county, state, and federal funds also available, the rural residents go blithely on their way, secure in the belief that they will be assisted in their economic difficulties The expenditures of government within the county for 1938 totaled over four million dollars (see

Table III), representing more than ninety dollars for every man, woman, and child (1930 census) A third of this total was allocated to welfare relief

Two areas show abnormally high per capita government expenditures One of these is the iron-mining district, where the taxes on mining property having an extremely high valuation pay for a large part of the public services and ease the burden on the resident taxpayers The mining companies seem not to begrudge superior schools and roads in the towns and villages which contain miners and their families

The second area is composed of the rural districts that have small, widely scattered farms In these districts the transportation of school children and the construction and maintenance of farm roads are expensive The cost of one extra mile of snow removal in the winter usually is greater than the total amount of taxes paid by the farmer whose property the road serves Until the present zoning plan went into effect every farmer and any other rural resident, no matter how far from schools and highways, could demand, and was entitled to receive, road and school services

The continuance of high governmental expenditures in the areas outside the iron district will be a difficult problem in the future At

TABLE III

Local Governmental Expenditures for 1938 in Marquette County

County general fund	$ 781,214 50 *
Emergency relief (Emergency Relief Administration)	116,261 42 *
Total school expenses	1,132,267 58 *
Township administration	66,587 02 †
Municipal government expenditures	1,050,534 01 ‡
Works Progress Administration	895,795 11 §
National Youth Administration	23,342 48 §
Old-age assistance	91,410 30 §
Total	$4,157,412 42
Per capita expenditure (1930 census)	$94 50

* From the *Annual Report, Marquette County Board of Supervisors*, 1938.

† From data furnished by the Marquette County Board of Supervisors, committee on taxation and finance

‡ From data furnished by the city treasurers of Ishpeming, Negaunee, and Marquette

§ From data furnished by the county Emergency Relief Administration office

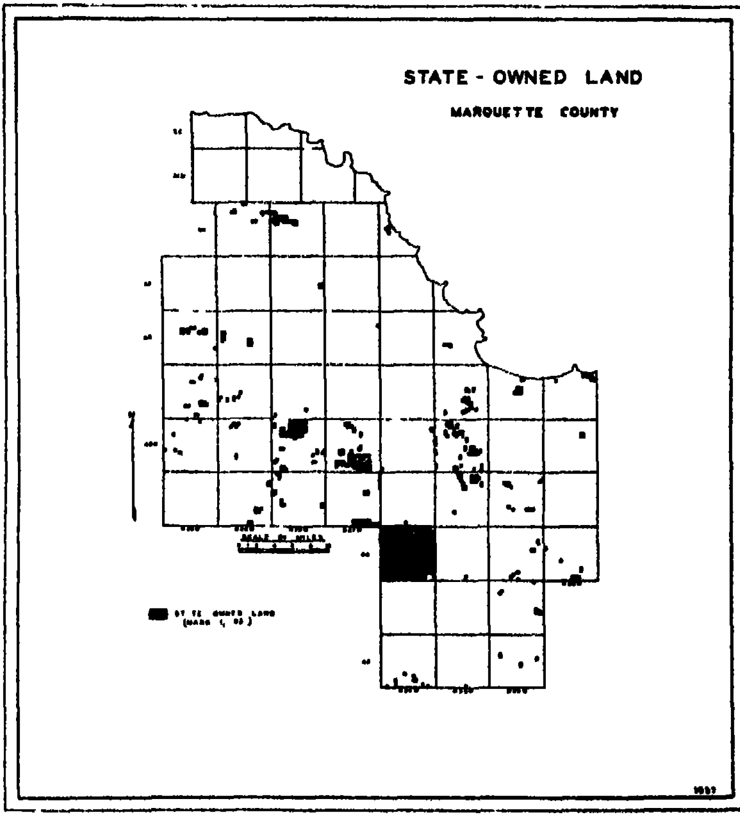

FIG 7

present a large share of the local taxes in these areas is paid by non-resident owners of timberlands But since much of this timber is already cut the land will soon revert to the state as tax delinquent, and thus be removed from the tax rolls. Immediately the tax burden, formerly assumed by the owners of such land, will be transferred to other property owners in the township Finally, either the tax rate will rise or public expenditures will be reduced Delinquency has already mounted in the cutover lands in the southern part of the county (see Fig 6), but little of the area has as yet reverted to state

ownership (see Fig 7)[8] The delinquent properties are still on the township assessment rolls, and their tax levies are still listed as assets, although many of the taxes will never be paid The blow has not yet fallen on the other taxpayers in these townships When it does come, it will be felt not through greatly increased tax rates (because of the 15-mill tax-limitation act), but through the only other alternative — reduced public expenditures This will affect the good agricultural districts as well as the poor, the only difference being that they will be better situated financially to withstand it

CONCLUSIONS

The rural districts of Marquette County have always been marginal areas for settlement Environmental factors produce certain conditions unfavorable for agriculture The principal disadvantages are the shortness and coolness of the growing season and the small amount of soils of high natural productivity Physical circumstances such as these have, however, influenced to a great extent only those farms whose operators make their entire living by farming Such farms are located mainly in the eastern and southeastern parts of the county and in a few scattered areas elsewhere Settlement over most of the county has been influenced much more by relationships with mining, lumbering, or recreational developments Only the sand plains seem to have been avoided or abandoned by all types of permanent rural occupation

Part-time farms and rural nonfarm homes have penetrated many of the areas that do not have favorable environmental conditions for their continued support The principal motivating force in this movement has been iron mining People, especially the Finns, moved out of the cities near the beginning of the present century to combine the advantages of subsistence agriculture with employment in the mines and the urban centers. When mining ceased to occupy as many men as before and when the urban centers started to lose population rapidly, such part-time farms began to have financial difficulties. The economic frontier of settlement had retreated. A similar situation resulted with regard to the part-time farms associated with lumbering. Although these settlements were not so numerous as those based on the mining–farming relationship, they

[8] Since 1938 the acreage of state-owned land in the county has greatly increased.

experienced the same difficulties when the timber resources were depleted But the part-time farms in the county have not been abandoned, and their occupants have not migrated to areas of greater economic opportunity These people still enjoy certain advantages All of them are able to demand and receive public services in the form of roads, schools, and welfare relief If their cash income fails they are certain of public aid The costs of such services are not paid by these settlers nor, to any great extent, by their more prosperous neighbors. Instead they are being met by nonresident owners of property within the local areas and by county, state, and federal-government funds

Growing uneasiness at the large expenditures for public services initiated the rural zoning movement in Marquette County The plan, which, as has been said, merely prohibits agricultural settlement in areas not now serviced by roads and schools, has been criticized because it did not take into consideration differences in the quality of the land That the procedure followed was urgent and justifiable is supported by much of the data accumulated during the preparation of the research dissertation of which this paper is a summary Even in the best agricultural areas public expenditures far exceed local tax returns Future scattered settlement in some of the better unused parts of the county would necessitate too great an outlay of government funds in comparison to the value of the improved land resulting from such settlement The zoning ordinance is elastic, however, and provides for amending the restrictions if necessary. The county officials have stated that such amendments would be made providing new settlement is made in large blocks, so that the difference between land values and governmental expenditures would not be excessive.

Marquette County well illustrates the pitfalls that can beset attempts to interpret human occupance solely on the basis of environmental factors or to draw zoning lines with reference merely to the quality of the land. Environmental factors set limits within which the economic frontiers fluctuate. In areas such as Marquette County, which are dominated by mineral exploitation, changes in that industry have violent repercussions on the social and economic structures These are transmitted to the cultural landscape in diverse ways Here, the decline in mine employment and the depletion of the timber reserves were indirectly responsible for the rural

zoning movement Whether an upturn in the mining industry or the regrowth of pulpwood in certain areas will mean a widespread alteration of the zoning plan in the future remains to be seen, both developments are possibilities Enough land serviced by roads and schools and unrestricted in the zoning plan remains, however, to provide for any normal growth of rural settlement

Here, at least, is something new in Michigan, and not common in other states — a frontier of settlement established by law. The principal factors responsible for this fixed frontier were not differences in the quality of the land, but certain social and economic conditions

It is interesting to speculate whether or not abnormally high governmental expenditures in other mining and lumbering areas often maintain "parasitic" settlement beyond normal frontiers The answer to this question can come only through similar studies elsewhere

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PLATES I–III

FIG 1 Characteristic jack-pine vegetation in the sand-plains area

FIG 2 An original stand of mixed white pine–balsam–paper birch, with a beaver dam in the foreground

FIG 3 A pulpwood logging camp north of Champion Both light and heavy trucks are now necessary

FIG 1 One of the few open-pit iron mines near Palmer (courtesy of L H Halverson)

FIG 2 A typical part-time farm

FIG. 1 A recently settled part-time farm west of Marquette

FIG 2 One of the modern dairy farms near Skandia

COMPARISONS OF CRITERIA FOR THE RATING OF AGRICULTURAL LAND *

JETHRO OTTO VEATCH AND IVAN F SCHNEIDER

IN A realistic world, where self-interest is a controlling motive, values of different kinds of land are not equal, whether the kinds are evaluated for the same use or for different uses Therefore demands arise for the classification of land on a quality basis, and it follows that individuals or organizations will attempt to satisfy the demands

When individuals or government agencies have made classifications on an economic basis, the results have never been entirely acceptable to all interests affected, and therefore questions arise about the validity of criteria and the value of the data which are used Since there is no generally accepted procedure, it occurred to the writers of this article that a comparison of two different methods of composing an economic rating of agricultural land for the same area might be of some value, or at least be of academic interest, since the study is concerned with a critical comparison of a few of the possible criteria which may be employed

The area selected for comparison is the State of Michigan One classification is based upon the average value per acre of land and buildings by counties as given by the United States Census of Agriculture for the years 1930 and 1935. In accepting this basis for rating the land in the separate counties of the state it is necessary to start with the assumption that the selling price, or exchange value, is, after all, a true reflection of inherent values of land or its productive capacity, and is therefore the proof of the pudding A second plan of rating the counties is based upon an agricultural land-classification map recently completed by the Michigan Agricultural Experiment Station.[1] This has a physical basis in that it represents an interpre-

* Authorized as Journal Article No 517 (N S) from the Michigan Agricultural Experiment Station

[1] Veatch, J O., *Agricultural Land Classification and Land Types of Michigan*, Special Bulletin 231 (Revised), Mich Agric Exper Station, 1941

TABLE I

COMPARISON OF AGRICULTURAL LAND RATINGS FOR MICHIGAN

Basis 1930 U S Census			Basis physical land classification *			Basis 1935 U S. Census		
Rank	County	Average acre value	Rank	County	Rating value	Rank	County	Average acre value
1	Wayne	$425 04	1	Clinton	32 16	1	Wayne	$136 04
2	Oakland	194.33	2	Eaton	32 08	2	Berrien	99 79
3	Macomb	183 64	3	Lenawee	31 60	3	Macomb	78.17
4	Berrien	149.95	4	Huron	31 50	4	Monroe	76 60
5	Monroe	128.57	5	Sanilac	31 20	5	Oakland	68.42
6	Washtenaw	104.98	6	Gratiot	30 48	6	Van Buren	68.08
7	Ottawa	92.34	7	Ionia	30 48	7	Bay	65.24
8	Gogebic	90 98	8	Genesee	30 24	8	Genesee	62 85
9	Van Buren	89.51	9	Hillsdale	30.23	9	Washtenaw	60 72
10	Bay	87 61	10	Shiawassee	30 11	10	Ottawa	60 34
11	Kent	85 76	11	Lapeer	29 52	11	Saginaw	60 16
12	Saginaw	84.48	12	Bay	29.52	12	Lenawee	59 17
13	Lenawee	81 78	13	Macomb	29 10	13	Kent	58 57
14	Gratiot	80.53	14	Branch	28 83	14	Ingham	58 12
15	Genesee	79.38	15	Washtenaw	28 80	15	Gratiot	56 91
16	Ingham	76.89	16	St Clair	28.52	16	Allegan	55 60
17	St. Clair	74.70	17	Calhoun	28.45	17	Kalamazoo	54.99
18	Allegan	73.52	18	Tuscola	28 14	18	Gogebic	53 49
19	Clinton	72.67	19	Saginaw	28 12	19	Muskegon	53 39
20	Kalamazoo	72.36	20	Ingham	27 90	20	Eaton	52.36
21	Shiawassee	71 91	21	Kent	27 65	21	Clinton	51 06
22	Muskegon	69 72	22	Berrien	27 50	22	Jackson	49 58
23	Livingston	67 12	23	Kalamazoo	27 40	23	St Clair	48.57
24	Eaton	65 06	24	Monroe	27 26	24	Ionia	48.28

* From a map published in Special Bulletin 231, *Agricultural Land Classification and Land Types*, Michigan Agricultural Experiment Station, 1941

Rank	County	Average acre value	Rank	County	Rating value	Rank	County	Average acre value
25	Lapeer	$ 64.87	25	Livingston	26 72	25	Shiawassee	$ 47 75
26	Tuscola	61 74	26	Jackson	26 57	26	Branch	45.45
27	Jackson	61 48	27	Oakland	26 34	27	Huron	45 37
28	Ionia	61 45	28	Wayne	25 71	28	Cass	45 32
29	Cass	58.93	29	Barry	25 60	29	Tuscola	44 89
30	Huron	57.33	30	Isabella	25 49	30	Hillsdale	44.45
31	Calhoun	57 06	31	Ottawa	24.96	31	Calhoun	42.62
32	Branch	56 69	32	Montcalm	24.90	32	Grand Traverse	42 17
33	Grand Traverse	56 45	33	St Joseph	24.67	33	St Joseph	41.82
34	Hillsdale	56.25	34	Van Buren	24.46	34	Montcalm	41 11
35	Isabella	54 18	35	Cass	24 12	35	Lapeer	40 59
36	Oceana	53.53	36	Allegan	23 62	36	Livingston	40.32
37	Iron	52.66	37	Ontonagon	23 34	37	Iron	39 93
38	St. Joseph	52.64	38	Leelanau	22.87	38	Mason	39 21
39	Montcalm	52 59	39	Alpena	22 11	39	Oceana	38 15
40	Mason	52.40	40	Antrim	21 77	40	Isabella	37 78
41	Barry	50.46	41	Arenac	21.58	41	Barry	36.21
42	Midland	49 92	42	Osceola	21 49	42	Midland	35.27
43	Leelanau	47 40	43	Houghton	21 42	43	Alger	33 09
44	Dickinson	46 07	44	Charlevoix	21 14	44	Sanilac	32 52
45	Sanilac	*45.41	45	Oceana	20 20	45	Baraga	32 32
46	Baraga	44.84	46	Midland	19 82	46	Leelanau	29 37
47	Ontonagon	44 41	47	Presque Isle	19 79	47	Newaygo	28.67
48	Alger	41 13	48	Mecosta	19 78	48	Marquette	28.06
49	Newaygo	40 45	49	Gogebic	19 72	49	Houghton	27 79
50	Menominee	38.76	50	Menominee	19 48	50	Menominee	27 25
51	Houghton	37 99	51	Dickinson	19 27	51	Delta	26 17
52	Delta	37 79	52	Grand Traverse	19 10	52	Dickinson	26 12
53	Marquette	37 31	53	Gladwin	18 58	53	Arenac	25 78
54	Mecosta	36.25	54	Iron	18 56	54	Keweenaw	25 03
55	Benzie	35 81	55	Emmet	18 45	55	Ontonagon	25 01
56	Arenac	35 29	56	Missaukee	18 44	56	Schoolcraft	25 01
57	Charlevoix	34 39	57	Cheboygan	18.42	57	Charlevoix	24 73

TABLE I (*Concluded*)

COMPARISON OF AGRICULTURAL LAND RATINGS FOR MICHIGAN

Basis 1930 U S Census			Basis physical land classification			Basis 1935 U S Census		
Rank	County	Average acre value	Rank	County	Rating value	Rank	County	Average acre value
58	Manistee	$33 44	58	Mason	18 29	58	Mackinac	$24 44
59	Chippewa	32.88	59	Wexford	18 11	59	Roscommon	23 18
60	Mackinac	32 06	60	Alcona	18 10	60	Benzie	22 70
61	Schoolcraft	31 39	61	Ogemaw	17 92	61	Manistee	22.57
62	Emmet	31 00	62	Alger	17 72	62	Ogemaw	22 52
63	Alcona	30.60	63	Clare	17 50	63	Luce	22 33
64	Alpena	30 07	64	Delta	17 11	64	Iosco	21 98
65	Missaukee	30.06	65	Chippewa	17 05	65	Mecosta	21 88
66	Osceola	29 75	66	Newaygo	16 96	66	Alcona	21.37
67	Gladwin	29 61	67	Manistee	16 60	67	Osceola	20 98
68	Antrim	29.57	68	Baraga	16 21	68	Chippewa	20 80
69	Cheboygan	27 44	69	Muskegon	16 08	69	Emmet	20 52
70	Keweenaw	27 43	70	Kalkaska	15 81	70	Antrim	20 40
71	Luce	27 40	71	Otsego	15 60	71	Alpena	20 36
72	Iosco	27 19	72	Montmorency	15 09	72	Presque Isle	20 00
73	Montmorency	27 02	73	Iosco	15 02	73	Gladwin	19 19
74	Roscommon	26 81	74	Benzie	15 00	74	Clare	18 73
75	Lake	26 53	75	Marquette	13 41	75	Missaukee	18.58
76	Ogemaw	25 88	76	Mackinac	13 32	76	Lake	18 43
77	Wexford	25 71	77	Oscoda	12 69	77	Crawford	17 63
78	Presque Isle	25 55	78	Roscommon	12 44	78	Wexford	16 97
79	Clare	25 52	79	Luce	12 38	79	Cheboygan	16.80
80	Oscoda	24.63	80	Lake	12 27	80	Otsego	16 60
81	Otsego	22.21	81	Crawford	11 82	81	Montmorency	16.55
82	Crawford	21 47	82	Schoolcraft	11 80	82	Kalkaska	16 02
83	Kalkaska	20.47	83	Keweenaw	11 32	83	Oscoda	16 00

tation of natural land types in terms of agricultural use From yields of plant growth and response to agricultural management, so far as these are known for natural land types, or soil types, qualitative ratings are assigned to each land type and the ratings extended throughout the geographic range of a type whether or not the land is in cultivation The money value of land and the economic environment are not primary considerations In the publication referred to all the land of the state is separated into four classes, and the acreage of each class is estimated for individual counties

In order to place this scheme on a comparable basis with that derived from the Census each of the four land classes is given an arbitrary, but uniform, value per acre The average acre value thus obtained is used solely for the purpose of arranging the counties in order of their rank The two classifications are presented in Table I to facilitate comparison From a study of the table it is evident that no close agreement exists between the two Consequently, doubts may arise in the mind of the reader about the soundness of either rating or both In the Census rating there is a strong suspicion that the figures do not necessarily represent actual agricultural values Extraneous factors, such as speculative values for nonagricultural uses, have certainly determined the high rank of Wayne, Oakland, and Macomb counties, for by any other tests these counties would have a lower rating

The physical classification is also vulnerable to adverse criticism, since it is not precisely mathematical, but, on the contrary, is in a large measure qualitative and subjective Also, there is a basis for the contention that the two schemes are not properly comparable, since the physical classification embraces all land and the Census only that which it designates as agricultural However, even in those counties which are almost entirely in farms there is no close agreement If, in the physical classification, the counties are ranked according to the amount of first-class agricultural land which they contain there is still no agreement with the Census figures

Inasmuch as neither the selling price, or exchange value, of agricultural land nor the values on a physical basis are entirely acceptable, the possibility of use of other criteria may be considered Possible criteria for a qualitative classification of land on an agricultural basis are (1) net income from land, (2) money value of agricultural products, (3) measured yields of crops, (4) selling price

of land, (5) values assessed for taxation purposes, (6) value of farm buildings, (7) physical character of the land

Logically, net income from land should be the best test of quality, but any extensive classification on this basis is impracticable because net income is an elusive thing and published data are not available Even if farm-management accounts have been kept for a period of years for units as large as a township the resultant land classification would be defective unless other factors were considered, such as the competence of operators, the type of farming, and the size of farm units Further, income would not provide any basis of agricultural classification of land not in farms

The gross value of agricultural products is a possible basis or test of a classification, but is objectionable as a single criterion, since values fluctuate widely, are difficult to obtain for all products, and are reported by political units instead of by land types

Yield of crops has some virtue not possessed by other criteria These data, however, are not very dependable if relied upon alone, since statistics are not complete and are available only by political units

Selling price of land and assessed values may be considered together and dismissed as not being entirely trustworthy, for in too many instances extraneous factors determine the figures Figures vary widely for the same kind of land, inasmuch as economic environment and political conditions may be controlling factors rather than actual agricultural worth

Farm buildings and other farm improvements reflect the quality of the land either well or poorly In some older settled regions, where sufficient time has elapsed for trial-and-error adjustments to take place, farm improvements are a reflection of the worth of the land However, for certain types of farming which are based upon a single crop, for absentee ownership of land, and for pioneer regions, this criterion may have little or no value

The physical character of land may serve as a basis of economic land classification by assigning ratings to soil types or other natural units of land The ratings are tacitly based upon experience in land use and involve some one or all of the preceding criteria The physical basis has an advantage in that all land, whether in farms or not, may be classified, and that favorable qualities or limitations for agricultural use may be inferred from the chemical and physical properties

of the soil which may not be revealed at a particular time by selling price, assessed values, yield of crops, or farm improvements

Judged by strict standards, any economic land classification covering states or regions and based upon the criteria listed above cannot be precisely mathematical Nevertheless, qualitative, or more or less subjective, classifications may be made which can have considerable value for the inventory of land resources and for land planning if a combination of criteria is involved in making them rather than a single factor

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GEOLOGY

THE DISTRIBUTION OF DRUMLINS IN MICHIGAN

STANARD G BERGQUIST

INTRODUCTION

ALTHOUGH drumlins make up a relatively small part of the glaciated landscape in Michigan they are rather widely dispersed in both the Northern and Southern peninsulas (Fig 1) Of the nine areas described in this report only two, the Grand Traverse and Menominee districts, carry sufficient drumlin forms to compare in importance with the areas of concentration in New York and Wisconsin The drumlins in Michigan present a rather wide variety of form and outline, ranging from low, poorly developed oval drumlinoids to the elongated linear types which display striking asymmetry of stoss and lee slopes They are all superposed upon areas of till plain and were formed by the activity of readvancing ice

Drumlins are associated with each of the various lobes that played a part in developing the surface features of both peninsulas of the state In general, the forms are aligned with trends more or less parallel to the glacial striae in the bedrock and perpendicular to the axis of the moraines from which the ice sheets readvanced On the Lake Huron side of the state, however, there is a marked discordance between the trends of the axis of the drumlins and the moraines and likewise in the markings in the rock pavement This unusual relationship reflects multiple activities of the ice sheets as they deployed over the surface.

No attempt has been made in this report to account for the origin of the drumlins in Michigan This general problem has been under discussion for the past seventy-five years, with the result that many theories have been advanced to explain their development. None of them seem adequate, however, to satisfy all the requirements involved in this complex problem

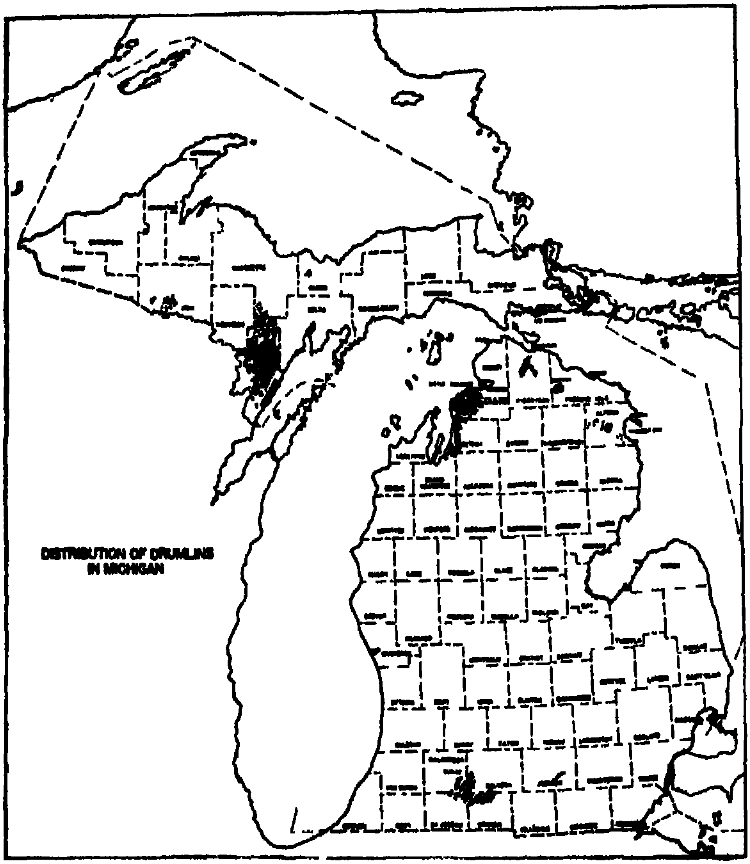

FIG 1

DRUMLIN AREAS IN THE SOUTHERN PENINSULA

The Climax — Union City Area

A cluster of small drumlins and drumlinoid ridges is spread out on the interlobate till plain situated just outside the Tekonsha moraine in parts of Kalamazoo, Calhoun, St. Joseph, and Branch counties The plain stands at an elevation of 900 to 960 feet above

sea level and was formed by the combined activities of the Michigan and Saginaw lobes when the ice front retreated from the Sturgis moraine After the ice moved forward to form the Tekonsha moraine there was a readvance of the Saginaw lobe over the till plain, the surface of which was then resculptured into a series of more or less parallel ridges which now feature the landscape From the direction of trend of the ridgelike hills it is apparent that the drumlin-shaping process was due in large measure to the activities of the Saginaw lobe It seems probable that, while this ice front was readvancing over the till plain, the Michigan lobe held its position without much movement on the west limb of the Tekonsha moraine Since the final retreat of the ice from this area the till plain has been sliced into a series of parallel strips by streams whose southwest courses were unquestionably influenced by the drumlin trends

The drumlinoid hills of the area are composed of clayey till, similar in composition and texture to that which makes up the plain upon which they are superposed The hills are roughly oval and more or less symmetrical in outline There is no appreciable difference in the degree of slope on the stoss or front and the lee or tail ends The majority of the forms are rather low, with crests rarely exceeding 30 or 35 feet above the surface of the plain They range in length from one eighth to three quarters of a mile and in width from one tenth to one fifth of a mile The general trend of the drumlinoid hills ranges from S 30° W on the west edge of the plain south of Climax to S 40° W on the east edge of the area near Union City

This is the oldest of the drumlin areas in the state and was developed shortly after the Saginaw lobe had made its second important halt upon recession into Michigan

Alpena County

Several small clusters of drumlins are distributed over the till plain in the region to the south and west of Alpena The forms are rather widely scattered in the area, extending from near Hobson to the southeast portion of the county They were developed on a till plain, with an elevation of 700 to 800 feet above sea level, that was formed in the retreat of the Huron lobe from the main ridge of the Port Huron moraine

In the areas directly south of Dafoe and west of Ossineke the drumlins have a trend which is generally S. 35° E They are aligned

more or less parallel to the shore of old Lake Algonquin, and it seems probable that a fairly large portion of the original drumlin section on the east side of the district may have been cut away by the waters of that lake

In general, the drumlins trend parallel to the axis of the morainic ridges and hence also to the retreating ice front that formed the moraines of the area. It may be inferred from this relationship that they were formed by an ice movement different from that which was responsible for building up the moraines The glacial striae and grooves in the rock pavement to the north of the drumlin area bear generally S 55° E Thus it may be seen that there is a marked discordance of trends between the drumlins, the bedrock markings, and the major axis of the moraines, the implications of which will be discussed in a later paragraph

Presque Isle County

A series of well-defined elongated ridges with distinct troughs between them is situated on the till plain immediately east of Onaway The drumlins in this area are composed of bouldery till containing a heterogeneous mixture of all types of material, much of it of local derivation The till plain which carries the drumlins stands at an elevation of 800 to 900 feet above sea level and was formed by the ice of the Huron lobe as it retreated basinward from the main axis of the Port Huron moraine

On the western edge of the plain, near Onaway, the ridges are low and somewhat drumlinoid in character They increase in size to the eastward and attain a relief of nearly a hundred feet on the east side of the area The drumlins are lined up with their major direction more or less parallel to the axis of the morainic ridges in the area. They trend generally S 40° E , whereas the glacial grooves and striae in the bedrock exposures near by bear S 27° E

In this section, as in the Alpena district, there is a definite discordance in trends between the drumlins, the rock markings, and the alignment of the morainic ridges It is obvious that the ice movement that produced the drumlins was not the same one which was responsible for the scratches on bedrock or for the construction of the morainic features The author is inclined to the view that detailed mapping of the till plain will reveal the presence of numerous drumlins not indicated in Figure 1

Cheboygan County

A small cluster of rather well defined drumlins is situated in the clayey lacustrine plain near Aloha, on the east side of Mullet Lake They appear to have been formed on a till plain that was spread out by the Huron lobe upon its retreat from the inner ridges of the Manistee moraine to the position of the Cheboygan ridge The latter moraine marks the final stand of the Huron lobe in the Southern Peninsula previous to its retirement into the lake basin

The drumlins in this area protrude above the clayey plain, whose elevation ranges from 600 to 650 feet They were completely covered by the waters of Lake Algonquin, the shore of which is marked by features that stand at a level of 740 feet above sea level During this stage of inundation the forms were thoroughly washed by water, and in all probability much of the finer material was carried away Again, in the Nipissing stage of lake development the portion of the plain below the level of 625 feet was covered by water, with the result that certain of the drumlins were further scrubbed by waves

The drumlins in this area bear generally S 40° E They are aligned in a direction more or less parallel with those near Onaway and Alpena farther south and were undoubtedly formed by the same ice movement which was responsible for their sculpturing The Aloha drumlins have a trend which is roughly parallel to the morainal ridges that mark the position of the retreating ice border They do not conform with the glacial grooves and striae whose bearings on the rock pavement at Tower dam and Marvin quarry are S 27° E. These drumlins are the youngest in the Southern Peninsula and were formed by the Huron lobe in its final readvance before leaving the Straits of Mackinac

DISCORDANCE OF TRENDS A REFLECTION OF MULTIPLE ICE ACTIVITY

The lack of alignment between the trends of the drumlins and the morainic ridges in the Alpena, Onaway, and Aloha districts may be referred to a conflict of activities in the ice sheets which deployed over the area The discordance of these trends as related to the bearings of the glacial markings on the rock pavement further complicates the picture

It is the opinion of the author that at least three episodes of ice

movement were involved in the development of the features expressed in the area The first and major advance of the Huron lobe is related to the activities which scored the rock surface The ice which was responsible for the formation of the Huron lobe had its origin in the ice-filled Superior basin It deployed across the lowlands of the Northern Peninsula and found its way into the Huron depression in the region to the east of the Straits of Mackinac This advance of the ice is marked by grooves and striae which run in a direction ranging from S 27° E in Cheboygan County to S 50° E in Alpena County

After the main ridge of the Port Huron moraine had been formed the Huron ice retreated slightly to the north of eastward across the northeast portion of the Southern Peninsula Pivoting on the Port Huron moraine, the ice front melted back into the Huron basin, leaving in its wake a succession of parallel north–south-trending morainic ridges.[1] (See Fig 2)

Before the final breakup of the lobe in the Huron basin there was a readvance of the ice from the Straits in a direction parallel to the major trends of the drumlins The movement of this mass of ice, confined between the previously formed morainic ridges, was thus directed into Thunder Bay near Alpena In its advance across the intermorainic plain the till was sculptured into a series of drumlins whose bearings range from S 35° E to S 40° E.

Grand Traverse Drumlin Area

An extensive area of drumlins is developed on the till-plain district lying between Grand Traverse and Little Traverse bays in parts of Grand Traverse, Antrim, Charlevoix, and Emmet counties The till plain was formed by the activities of the Michigan lobe during its retreat from the position of the Manistee moraine

In the northern part of the district the drumlins extend inland from Lake Michigan for a distance of twenty miles They have their best development in the section between Torch and Charlevoix lakes, where they assume the shape of linear ridges separated from one another by intervening sags The majority of the drumlins in this portion of the plain have a length which ranges from one half to three quarters of a mile, although some of the more prominent ridges

[1] Bergquist, S. G, "Surface Geology of Montmorency County, Michigan," *Pap Mich. Acad Sci, Arts, and Letters*, 25 (1939): 453–468 1940

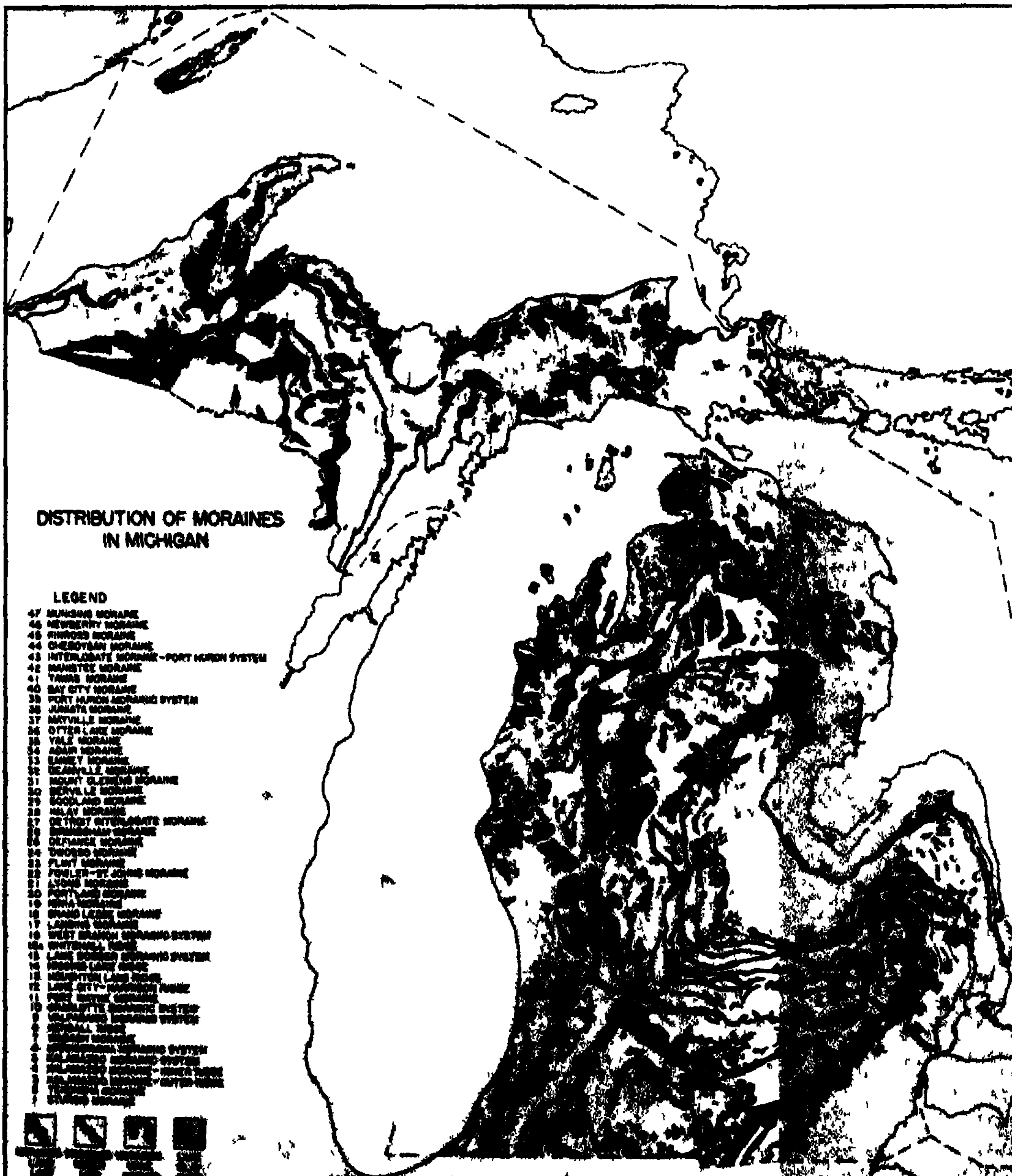
DISTRIBUTION OF MORAINES IN MICHIGAN
LEGEND
40 BAY CITY MORAINE
37 MAYVILLE MORAINE
36 OTTER LAKE MORAINE
35 YALE MORAINE
34 ADAIR MORAINE
23 FLINT MORAINE

Fig 2

attain a length of more than one and one-half miles In general, the drumlins range in width from one eighth to one quarter of a mile and are as much as fifty and sixty feet high In the southern part of the district the features are rather poorly developed and assume the form of oval drumlinoids In this sector the forms are crowded into a narrow belt of till plain immediately inside the Manistee moraine

Leverett[2] describes the drumlins as being "composed of very evenly mixed stony till, stones being distributed through almost every inch of the deposit In most of the exposures the till shows indistinct partings rudely concentric with the surface"

Along the border of Grand Traverse Bay the drumlins trend slightly east of south They run somewhat parallel to the great valleys which are occupied by Elk and Torch lakes In the district around Lake Charlevoix the direction of trend of the ridges changes abruptly, many of the forms assuming directions which average S 35° E There is a marked discordance between the trend of the drumlins and the direction of movement of the ice which was responsible for scouring the basin which now contains Lake Charlevoix

In the area between Torch Lake and the east arm of Grand Traverse Bay the ridges run generally parallel to the long axis of the marginal lakes It is doubtful, however, whether these rock basins were embossed by the same ice advance that remodeled the till into drumlin ridges

On the eastern edge of the till plain the glacial drift cover is very thin Many of the ridges which feature the landscape have been sculptured out of shale by the erosional work of the readvancing ice Near Ellsworth in Charlevoix County and also south of East Jordan in Antrim County some of the drumlins have their underpinnings in the Ellsworth shale

DRUMLIN AREAS IN THE NORTHERN PENINSULA

Iron County

The oldest area of drumlins in the Northern Peninsula is located on a till plain which is centered in the district of Iron River The drift of this plain may be attributed to an ice activity that was responsible for the Chippewa-Keweenaw ice tongues which were directed in their movement largely by the Keweenaw Peninsula

[2] Leverett, F, and Taylor, F B, "The Pleistocene of Indiana and Michigan and the History of the Great Lakes," *U. S Geol. Surv*, *Mon 53*, 310–315 1915

The Chippewa lobe was induced by the broad embayment west of the peninsula, whereas the Keweenaw tongue found its way through the narrow bay of that name to the east

The till plain which carries the drumlins is composed of a heterogeneous mixture of drift ranging in texture from fine clay to sand A wide variety of boulders, many of local derivation, are scattered over the surface and likewise incorporated with the material that comprises the drumlins

Russell [3] refers to this extensive plain as having a topography which is distinctly morainic He also separates the drift into an older red till east of the Chicaugon–Trout Lake depression and a younger overlying gray till to the west of the slough His interpretation of the topography of this plain was incorrect, for it is obvious that the ridgelike character of the surface and its drumlin associations would indicate deposition by moving ice rather than marginal deposition at definite stationary stages of ice retreat [4]

The general alignment of the ridges and valleys in the plain, together with the direction of the striae on the rock pavement, would indicate that the Chippewa lobe which sculptured the drumlins moved in from the northeast with a generally S 20° W to S 45° W trend The ridges range from low oval, symmetrical drumlinoids to well-defined elongated and smoothly rounded forms averaging one half to three quarters of a mile in length The drumlins are separated from one another by poorly drained sags and basins which hold numerous swamps, lakes, and minor drainage ways

Alger County

A small cluster of drumlins is situated on the north edge of the "Trenary" till plain in the vicinity of Eben. The plain is composed of a reddish loose-textured bouldery till containing an abundance of locally derived flat blocks of limestone and dolomite It stands at an elevation of 1,000 to 1,100 feet and was formed by the activities of the Green Bay lobe, which found its way out of the Superior ice mass through the Au Train–Whitefish depression.

The wide distribution of eskers over the surface of the "Trenary"

[3] Russell, I C, "The Surface Geology of Portions of Menominee, Dickinson and Iron Counties, Michigan," *Annual Report of the State Board of Geological Survey for the Year 1906*, pp 40–52

[4] Bergquist, S G., "Glacial Geology of Iron County, Michigan," *Pap Mich. Acad Sci., Arts, and Letters*, 16 (1931) · 363–372 1932

till plain suggests an origin by ice stagnation [5] A slight readvance of the ice across the north edge of the plain was responsible for the sculpturing of the drumlins.

The drumlins of the Eben district are somewhat steep-sided and elongated in a north–south direction They are made up of a heterogeneous mixture of reddish boulder clay and contain numerous slabs of local limestone and dolomite which are set into the structure without any definite orientation The ridges average about twenty to forty feet in height and range from less than a half mile to more than a mile in length They have a trend which is roughly north to south and are parallel to the direction of ice movement as shown by striae on adjacent rock exposures

Menominee Drumlin Area

With the exception of a few small morainal ridges which mark its west and southeast borders the surface of Menominee County may be regarded as comprising a vast till plain In his description of the area Ver Wiebe [6] states that drumlins are present in nearly every township, over six hundred individual forms have been counted in the twenty-five townships in which they are most prominent

The drumlins occur in the form of smoothly sloped ridges, elongated in the direction of the major ice movement The general axial trend of the forms is S 40° W, with a slight departure from this direction in the western part of the county The majority of the drumlins are about three quarters of a mile long, although a few of them are extended to a length of over one and one-half miles They have blunt stoss ends and taper off to gentle profiles on the lee or tail slopes

Double and triple drumlins, in which two or three parallel ridges are superposed upon a single drumloidal arch, are not uncommon Numerous eskers are associated with them They usually occur in the troughs between the drumlins and are aligned parallel to the major axis of the ridges Russell [7] describes a compound ridge im-

[5] Bergquist, S G, "The Pleistocene History of the Tahquamenon-Manistique Drainage Region of the Northern Peninsula of Michigan," *Michigan Geological and Biological Survey*, Publ 40, Geol. Ser 34, pp. 63–68. 1936

[6] Ver Wiebe, Walter A, "Surface Geology of Menominee County," *Pap Mich Acad Sci, Arts, and Letters*, 7 (1926) · 167–179 1927

[7] Russell, I C, "A Geological Reconnaissance along the North Shore of Lakes Huron and Michigan," *Annual Report of the State Board of Geological Survey for the Year 1904*, p. 77.

mediately south of Wilson, where a well-defined esker is perched upon the summit of a drumlin in such a manner that the longer axes of the two features coincide He cites "a conspicuous example of an esker extending in a direction approximately at right angles to the longer axis of the associated drumlin" in the area about half a mile northwest of the village of Spalding The drumlins of the Menominee district were shaped by the activities of the Green Bay lobe, which deployed over the till plain as a tongue protruding from the mass of ice which then filled the Superior basin

If we accept the viewpoints of Anderson [8] and Flint [9] that eskers are formed under conditions of stagnation, then it would seem to follow that the last ice sheet which advanced over the till plain must have stagnated after the drumlins had been formed In all probability the ice disappeared from the area as a result of ablation and evaporation This would lead us to the conclusions expressed by Alden [10] — that the eskers were formed subsequent to the shaping of the drumlins

The material in the drumlins of the Menominee district is ordinarily unassorted and unstratified In that respect it does not differ materially from the till of the plain out of which they were formed Occasionally a section shows rude bedding planes which are parallel to the surface contour of the hills, which indicates that melt water was actively at work during the drumlin-shaping interval

Mackinac County

A small isolated group of drumlins is situated on Les Cheneaux Islands in the district between Hessel and Cedarville They are distributed over a surface where relatively thin drift covers the bedrock Russell [11] describes the drumlins as being of the elongated type, in several instances from one to two miles in length and with a maximum width of five hundred to eight hundred feet. They have a height of forty to fifty feet above the intervening troughs They are composed of a compact clayey till of reddish color and contain

[8] Anderson, S A., "The Waning of the Last Continental Glacier in Denmark as Illustrated by Varved Clays and Eskers," *Journ. Geol*, 39 609-624. 1931

[9] Flint, R F, "The Stagnation and Dissipation of the Last Ice Sheet," *Geog Rev*, 19 256-289 1929

[10] Alden, W C, "The Drumlins of Southeastern Wisconsin," *U S Geol. Surv, Bull 273*· 43 1905

[11] Russell, I. C, "Drumlin Areas in Northern Michigan," *Am. Geol.*, 35 177-179 1905

numerous boulders, many of which are of local derivation The majority of the drumlins have a bearing S 52° E and are aligned parallel with the capes and the narrow rock ridges that make up the islands The trend of the striae in the rock pavement conforms closely to the direction of the drumlin forms

The drumlins are situated on an area that was previously covered by the waters of Lake Algonquin They were also under water during the Nipissing stage, at which time they were no doubt thoroughly washed and scrubbed by waves The prevalence of concentrated boulders and coarse material in them gives testimony to the removal of much of the finer material Many of the outlying drumlins are today partly submerged in the waters of Lake Huron and are being subjected to lacustrine wave erosion

The drumlins of Les Cheneaux Islands district were formed by a lobe which extended into the Lake Huron basin They were shaped by ice which readvanced over the till plain in a direction generally S 52° E after the Kinross moraine in Chippewa County had been constructed They trend more or less parallel to the axis of the Kinross ridge and show the same discordance that is manifested in the Alpena, Presque Isle, and Cheboygan areas in the Southern Peninsula Thus it is obvious that at least two movements of the ice were responsible for the development of the features in this portion of the state

The drumlin areas which have been reviewed in the foregoing pages represent those which are known in Michigan at the present writing The author is of the opinion that other districts as important as many of those referred to will be discovered when the surface features of the state are worked out in more detail

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THE DISTRIBUTION OF MINOR FAULTS IN THE TRIASSIC OF PENNSYLVANIA

DEAN B. McLAUGHLIN

INTRODUCTION

THE existence of numerous minor faults in the Triassic rocks of the eastern United States, particularly those of the Connecticut Valley, is so well known that it is almost taken for granted that those formations are extensively faulted wherever they occur This view has occasionally been carried to the extreme of suggesting that there may be manifold repetition of strata, and that the real thickness of the series is only a small fraction of the calculated value

The tracing of identifiable beds for distances of many miles along the strike, especially through pitching folds, has led the writer to conclude that unrecognized faults cannot produce more than a negligible effect on the apparent thickness[1] The field work in a large area is now near enough to completion to permit an attack on the question of faulting from a somewhat different point of view, namely, the distribution of observed minor dislocations and of exposures of sheared or crushed rock If there are any hidden faults of major importance, some of them ought to reveal their presence by the occurrence of disturbed outcrops

THE STRUCTURE OF THE TRIASSIC ROCKS

The principal structural features of the Newark series from the longitude of Princeton, New Jersey, westward to Reading, Pennsylvania, will be evident from a study of the structural map, Figure 1 Directions of strike of the beds are indicated by negative contours at intervals of 2,500 feet, measured from the base of the series These represent the stratigraphic elevations of beds which outcrop at the

[1] A portion of this evidence has been presented in earlier papers. McLaughlin, D B., "A Note on the Stratigraphy of the Brunswick Formation (Newark) in Pennsylvania," *Pap. Mich. Acad. Sci , Arts, and Letters*, 18 (1932) 421 1933 *Idem*, "Note on the Thickness and Structure of the Triassic Series in Pennsylvania" (Abstract), *Bull. Geol. Soc. Am.*, 44 . 178 1933

average land surface (about 400 feet above sea level) Only sedimentary formations have been included in the totals The larger areas of diabase are also exhibited on the map

In calculating the contours the Delaware River section was adopted as fundamental, and the base of the Stockton formation there was taken as zero The Stockton-Lockatong contact lies at 4,500 feet, and it is assumed that the trace of that horizon establishes the 4,500-foot contour throughout the area in which it occurs[2] Higher and lower stratigraphic levels were computed relative to the base of

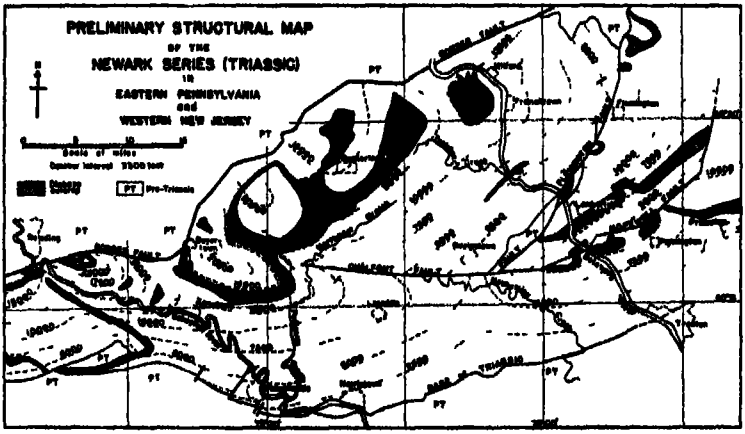

FIG 1 Structural map of the Triassic rocks in eastern Pennsylvania and western New Jersey The contours are negative and indicate stratigraphic elevations above the base of the series for beds which outcrop at the average land surface (elevation about 400 feet above sea level) Local uncertainties of some contours are referred to in the text Diabase is not included in the thicknesses

the Lockatong by means of observed dips and widths of outcrop, but these were adjusted on identifiable strata, such as the black-shale beds in the overlying Brunswick formation, wherever they occurred. Systematic effects due to errors in the measurements of strike have

[2] Doubtless this is not strictly true, especially west of the Schuylkill River, where the Lockatong thins and disappears. But its base is the most nearly fixed easily identifiable horizon in the lower part of the series, and until a more reliable substitute can be found (or until its variation can be measured) it appears worth while to adopt it as fixed for practical purposes.

thus been avoided wherever key horizons were available [3] The implied assumption that similar thicknesses of strata occur in different sections between any two given horizons is apparently not seriously in error within the region of deposition of black shales Some systematic variations are to be expected from east to west, in view of the differences in the conditions of sedimentation [4] It is seen that the lower half of the Stockton formation disappears westward and that the 2,500-foot contour abuts against the underlying crystalline rocks several miles west of Phoenixville

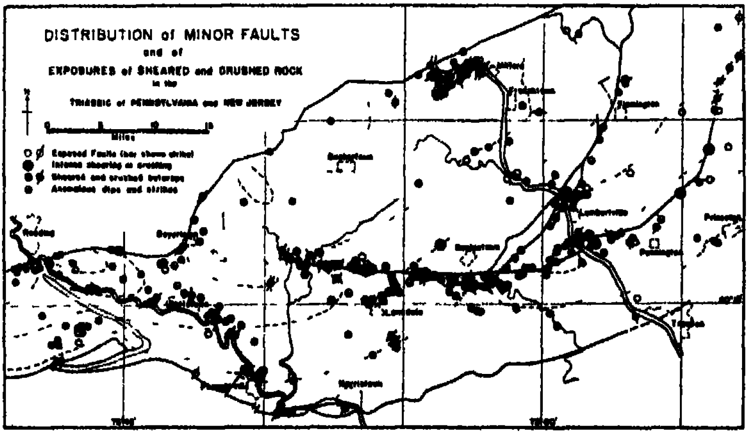

FIG 2 Distribution map of the area represented in Figure 1, showing locations of exposed minor faults and disturbed outcrops Only the alternate contours from Figure 1 are reproduced Diabase areas are not shown, except for the dike which occupies a fault (lower left-hand corner of the map)

Over a large part of the region the rocks dip toward the north and northwest Along the Delaware River northwesterly dips of ten to twenty degrees are the rule The Hopewell and Flemington faults cut across the Newark rocks in western New Jersey and cause a large portion of the series to be repeated in three belts Within each of

[3] The contours on B S Lyman's map of a part of this area (*Penna Geol Surv*, *Final Rep.*, Atlas: sheets 10 and 11, 1895) differ systematically from those determined by the writer, probably for the reason given

[4] McLaughlin, D B., "A Great Alluvial Fan in the Triassic of Pennsylvania," *Pap Mich. Acad., Sci, Arts, and Letters*, 24, Part IV (1938) 59 1939

the three areas the tilted strata maintain approximately the same strike for a number of miles, though some broad flexures are superimposed upon the principal monoclinal structure

North of Pennington the Hopewell fault has a displacement of about 7,000 feet, with downthrow to the southeast It does not bring up the base of the series, probably 3,000 feet of the Stockton formation lies beneath the surface According to Hawkins,[5] the displacement increases to 10,000 feet about twelve miles northeast of there The fracture nearly dies out in Pennsylvania, and the contours in Figure 1 imply an actual reversal of the direction of throw about five miles west of the Delaware, but this particular feature is uncertain

The Flemington fault has an equally large displacement, reaching a maximum of about 10,000 feet at the Delaware River, with downthrow to the southeast Just southwest of the river it exposes Cambrian quartzite and limestone beneath the Stockton formation in a belt several miles long Where it crosses the river the great fracture has two branches which are joined at both ends and form a small lenticular mass between the major fault blocks

The Flemington and Hopewell faults join a few miles southeast of Doylestown, Pennsylvania From there westward the fracture is known as the Chalfont fault The displacement decreases from about 5,000 feet at its eastern end until it passes into a pitching anticline about eighteen miles to the westward For two or three miles south of the Chalfont fault the strata dip southwestward This should not be regarded as true drag, rather, the structure appears to be a faulted anticline, of which the beds that dip southwestward form the southern limb

Farther west to the longitude of Reading the lower 10,000 feet of the series dips northwestward with broad gentle flexures which produce northeasterly dips west of Phoenixville and northwesterly in the area directly south of Reading A large diabase dike occupies a fault near the southern border ten to fifteen miles west of Phoenixville, and pre-Triassic rocks are exposed as an inlier just north of the dike The intrusive enters the Triassic area just east of the inlier and cuts northwestward across 10,000 feet of strata in a distance of twelve miles Throughout that course it evidently occupies a fault

[5] Hawkins, A C, "Major Faulting in the Triassic of New Jersey" (Abstract), *Bull Geol. Soc Am*, 51 1994 1940

whose displacement is about 2,500 feet, with the downthrow on the northeast side

Most of the intrusive bodies of diabase occur in the Brunswick formation, the uppermost of the three principal members of the Newark series West of the Delaware River the principal igneous mass is a sill 2,000 feet thick, with its lower contact at a variable level of 12,500 to 14,500 feet above the base of the Stockton This sheet and the entire upper part of the sedimentary series are thrown into broad folds that are cut off by faults at the northern border North of Flemington, New Jersey, the folding also involves the lower formations, and the base of the Stockton is exposed at the northern boundary There the beds dip southwestward on the limb of a broad syncline Other wide basins occur north of the diabase outcrop One of these lies about Quakertown, the next is several miles farther southwest, and the third is east of Boyertown It contains shales whose stratigraphic position is more than 20,000 feet above the base of the series Between Pottstown and Reading there is a still deeper syncline on whose flanks steep dips occur At its center, close to the border near Reading, an extrusive sheet of basalt lies at a stratigraphic level of 23,000 feet, and the shales and sandstones that overlie it are undoubtedly the youngest Triassic sediments in the entire region

The accuracy of the contours in Figure 1 varies from one part of the map to another They are believed to be quite precise up to 12,500 feet in the region west and north of the Flemington and Chalfont faults Over most of the remaining area they are considered good approximations, except for local uncertainties [6] In the synclinal basin about Quakertown, however, and in the next trough southwest of there the placing of the 15,000-foot contour is only rough

EVIDENCES OF FAULTING

For our purpose a minor fault may be defined as one which does not have at any place a displacement equal to a large fraction of the thickness of one of the principal formations For definiteness we may name an upper limit of roughly 500 feet

[6] The most important of these doubtful features are (1) the 5,000-foot level in the southern belt where it abuts against the Chalfont fault, (2) the 7,500-foot contour west of the Delaware, just north of the Hopewell fault, (3) the 10,000-foot contour near Pennington, and (4) the 12,500-foot contour south of Flemington.

Evidences of dislocations fall into three classes

1 Some faults are actually exposed and produce visible displacement within a single outcrop These require no further comment We group with them a number of faults which have been inferred from offsetting or sudden disappearance of recognizable strata, such as the black shales within the red Brunswick beds

2 Exposures of sheared, slickensided, shattered, and brecciated rock furnish strong evidence Abnormal joint patterns and especially intense jointing may indicate the proximity of a fault

3 In the Newark rocks, in which folding is on a broad and open scale, anomalous dips and strikes are very significant Small abrupt local flexures of strata are included in this group In general, only a strike differing from the regional value by 45 degrees or more was considered discordant, but the limit had to be varied according to the character of the rock and of the exposure, and one very conclusive discordance of twenty degrees has been taken as significant Differences of dip without change of strike were not admitted unless they involved deviations equal to the regional dip for angles of fifteen degrees or more

The positions of disturbed outcrops are plotted on the distribution map, Figure 2, on which the three categories described above are distinguished by different symbols In some regions, owing to the dense clustering of faults and sheared exposures, it was impossible to plot all of them on the map, so that it falls short of representing the true intensity of the heaviest concentrations On the other hand all isolated localities are indicated It would be an overstatement to say that every exposure of rock in any given area has been examined, but it is certain that a very large sample has been observed. Moreover, some regions have been traversed only in reconnaissance, whereas others have been studied with the utmost care With these qualifications it is believed that the data give a picture of the extent of faulting in the Triassic rocks which is correct in its essential features

Only the alternate contours from Figure 1 are reproduced in Figure 2 In order to avoid crowding the latter map the diabase areas also are omitted, with the exception of the large dike in the lower left-hand corner; its outline is shown, since it marks the course of a major fault.

RELATIONS OF DISTURBED EXPOSURES TO THE MAJOR FAULTS

Inspection of Figure 2 reveals interesting groupings of the disturbed localities It was to be anticipated that the exposures of sheared, shattered, and crushed rock would follow the principal lines of dislocation, and this is abundantly confirmed On the basis of the distribution of such outcrops alone, without reference to other effects incident to major faulting, we could trace the approximate courses of the Hopewell-Chalfont and Flemington fractures Further, we may conclude that the lack of any equally conspicuous lines of crushing in other localities indicates that there are no other faults of similar magnitude in the area under consideration

It might have been expected that the observed minor faults would show a rather haphazard distribution over the entire region, but there is no such effect They also are strongly concentrated in the vicinity of the two major faults Indeed, for a distance of several miles they serve to indicate the northward prolongation of the belt which is disturbed by the Hopewell fault At the other extremity the presence of several minor dislocations and shear zones on Perkiomen Creek indicates the westward extension of the Chalfont disturbance

It is noteworthy that the strikes of the minor faults from south of Doylestown to Perkiomen Creek show no tendency to parallel that of the major fracture In fact, there seems to be a preference for strikes nearly perpendicular to the trace of the Chalfont fault On the other hand, the several dislocations on the northward extension of the Hopewell fault do seem to tend toward alignment with it

The anomalous dips also are clustered strongly toward the principal lines of fracture These discordances are by no means obviously caused by drag, in many places the strikes are almost perpendicular to, instead of parallel with, the major faults Such a relation, if produced by drag, must imply not only a vertical displacement, but horizontal motion as well The general impression that is conveyed is that the directions of the anomalous dips are systematic over limited distances, but haphazard when larger regions are considered, and that no simple horizontal shearing could have produced them. Rather, they seem to represent variations of displacement of the major fault with which they are associated, or diverse tilting of the small blocks which are bounded by the minor fractures that

traverse the rocks near the larger dislocations Discordant dips which are apparently quite random in direction occur abundantly along Neshaminy Creek from a point south of Doylestown to Chalfont five miles west of there

Besides the marked clustering of disturbed outcrops along the principal dislocations within the Triassic rocks there are groups of localities and scattered individual ones near the north border, which is determined by a major fault or system of faults The dense group west of Milford, New Jersey, where the Delaware River enters the region of Newark outcrop, will be discussed below The fact that there is not a strong concentration of localities all along the north border can be attributed in large measure to the character of the rock Much of it is coarse conglomerate which is deeply weathered and, consequently, is poorly exposed, except where it has been cut through by the Delaware and Schuylkill rivers Small faults and shear zones thus escape detection at many places along the northern boundary

IMPORTANT GROUPS OF MINOR FAULTS AND DISTURBANCES

The significance of clusters of disturbed outcrops will now be discussed Many of these exposures, taken by themselves, could hardly be regarded as establishing the existence of faults But when they are considered together, their grouping and especially their alignments strongly suggest the location of previously unknown dislocations The localities will be taken in order from east to west

1 About one and one-half miles east of the Delaware River the Hopewell fault, as mapped in the Trenton folio,[7] makes a sudden turn southward (see Fig 3), at the river it bends again westward and passes between Bowman Hill and Jericho Mountain. There is good field evidence in support of this interpretation, yet the most obvious line of crushing is not along the fault as mapped, but about one mile north of it Locations of disturbed outcrops are shown in Figure 3 The zone of shattered rock passes through the Mercer County Workhouse quarry at Belle Mountain on the New Jersey side of the river and follows a course north of Bowman Hill in Pennsylvania, thence west and southwest, and it probably joins the other branch of the fault near the west end of Jericho Mountain

[7] Darton, N H, and Kummel, H B, *U S Geol Surv*, Folio 167· Areal Geologic Map 1909

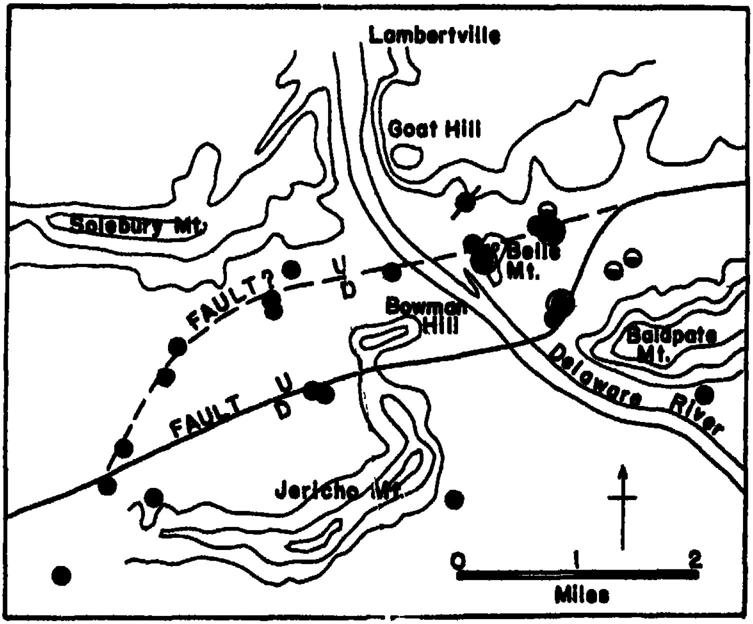

FIG 3 Distribution of disturbed outcrops south of Lambertville, New Jersey The 200-, 300-, and 400-foot topographic contours are reproduced to outline diabase hills (cf Fig 1) Half-filled circles indicate anomalous dips, filled circles, sheared or shattered exposures, circled spots, very intense shearing The full line shows the course of the Hopewell fault as mapped in the Trenton folio, the dashed line indicates the inferred course of another branch of the fault

about three miles west of the Delaware The resultant small block of sediments, with an intrusive body of diabase (Bowman Hill and Belle Mountain), is similar to the lenticular mass between the main fault blocks north of Lambertville

2 Probably the most interesting disturbed area lies west of Milford, New Jersey In the excellent outcrops along the Delaware River and along the northward-flowing creek which joins the river about one and one-half miles southeast of the border there are many faults and shear zones. These trend northeast and north-northeast, and in the principal faults the downthrow is on the southeast side A few examples of the reverse displacement were observed, how-

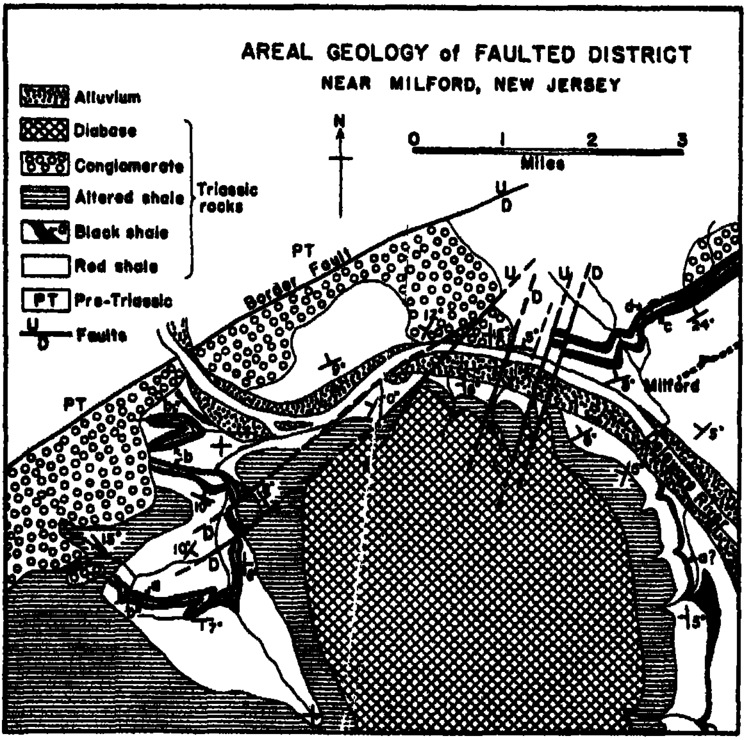

FIG 4 Geologic map of the faulted district west of Milford, New Jersey Boundaries between red and altered shale (baked by diabase) are gradational Black-shale members are designated *a*, *b*, *c*, *d* in ascending order Most of the conglomerate-shale boundaries are gradational (both vertically and along the strike), but the eastern end of the large conglomerate area may be determined by a fault The northeast end of the large Haycock diabase sill lies just outside the area shown in the lower left-hand corner of the map The northeastward extension of the altered shale along the south side of the conglomerate, shown at the left-hand side of the map, is attributed to a buried intrusion

ever. A geologic map of the area is given in Figure 4 The aggregate throw of the faults which cross the river amounts to at least 500 feet, but probably does not greatly exceed this figure Toward the northeast they are lost in a region of scarce exposures, and the eastern ones disappear southward in the large area of diabase that

caps the plateau The two which lie farthest west evidently continue southwestward and cut into a small dome of red shale, which contains two black-shale members These faults are finally lost in a region of few outcrops The southern of these two dislocations is actually composite Exposures along Highway U S -611, which parallels the creek, show at least six faults within a distance of only a little more than one hundred yards, all with a southeasterly dip of about forty-five degrees Similarly, where two fractures are shown to join in the conglomerate north of the river, there are five observable faults Between this disturbed area and the north border a few shear zones occur but they do not appreciably offset the black-shale strata, and they are omitted from the map

3 Five miles west of Doylestown a zone of anomalous dips, with a few sheared outcrops, branches from the Chalfont fault and trends southwestward, passes just north of Lansdale, and disappears (see Fig 2) Probably it marks the course of a large minor fracture Exposures are relatively few, and it is not possible to trace identifiable beds, so that there is no reliable indication of the amount of displacement The discordant dips are chiefly eastward, in contrast to the normal westerly to northwesterly dip of adjacent areas, hence it appears that the downthrow is on the southeast side

4 A cluster of faults southeast of Lansdale represents the large Gwynedd cut of the Reading Railroad Several strike faults are exposed there, and the dip of the Lockatong formation is much higher than at places east or west of that locality According to the maps in the Philadelphia folio,[8] the width of outcrop of the Lockatong at that place is decidedly constricted These several facts are probably related, and the abundance of strike faults in the Gwynedd cut cannot be regarded as necessarily typical of the whole region

5 North of the Schuylkill River a line of disturbed exposures trends northwestward, passing just north of Pottstown, and appears to lead to the border northwest of there To some extent this grouping may be fortuitous, since the sheared exposures two miles east of Pottstown are associated with a diabase dike which strikes north by east through the region It appears possible, however, that an obscure fault passes northwestward through that area More field work will be required to establish the character of this disturbance,

[8] Darton, N. H , *U S Geol Surv* , Folio 162. Areal Geologic Maps 1909

which seems to bear a relation to the anticline separating the deep basins that lie northeast and northwest of Pottstown

6 A probable dislocation is indicated by a southwestward trending group of anomalous dips south of the large diabase dike and north of the pre-Triassic inlier in the southwestern part of the map (Fig 2) The rock of the area is conglomerate and is not abundantly exposed The discordant dips are chiefly northeastward, as distinct from the northwesterly regional dip Two or three faults are exposed in railroad cuts within the area

7 The recognition of the cluster of localities just south of Reading is mainly due to the better exposures there, and not to more abundant faulting than at other places along the north border

SMALLER DISTURBANCES

Besides the evident clusterings just described there are a number of isolated localities and less obvious groups that deserve specific mention Again we take them in order from east to west

1 Southwest of Princeton discordant dips are associated with a sharp flexure of the Stockton-Lockatong boundary and of the 5,000-foot contour A connection with the anomalous dips north of Pennington is suggested It does not appear possible to decide from available evidence whether this represents a fault or a fold The former is suggested by the disturbed outcrops near Princeton, but evidence outside that locality is limited by scarcity of exposures

2 Anomalous dips and a small fault west of Pennington are perhaps due to a near-by intrusive mass rather than to the effect of the Hopewell fault

3 At Point Pleasant, Pennsylvania, on the Delaware River seven miles northwest of Lambertville, and at Byram station, New Jersey, just opposite, a displacement of the Lockatong black argillite is associated with a small sill and the dike along which the magma ascended

4 From a point on the Delaware River four miles south of Frenchtown a line of disturbed localities trends southwestward for several miles. Anomalous dips occur at the extremities of the line, and at its middle east of Tohickon Creek a thick black-shale member appears to be locally missing A fault is inferred, with a maximum displacement of about one hundred feet, but the evidence does not appear conclusive.

5. An offset of one of the black-shale members in the Brunswick formation occurs three miles east-southeast of Frenchtown, and it is thought to be related to an anomalous dip one mile east of that borough These disturbances are probably not connected with those described in section 4

6 The isolated spot on the map indicating a locality of large disturbance three miles northwest of Doylestown refers to a friction breccia, fragments of which were found in the dump of the old lead mine at New Galena

7 A fault is exposed in the Reading Railroad cut at the bend of the Schuylkill three miles southeast of Phoenixville The same dislocation is visible in a road cut about one-half mile southwest of there and close to the base of the formation It strikes northeast, in common with the other minor offsets which occur in the lower portion of the series south and west of Phoenixville and, like them, it has the downthrow on the east side Several small faults are exposed in cuts of the Reading Railroad farther north along the river between Phoenixville and Pottstown

8 West of Pottstown some exposures of sheared and slickensided rock occur near the sharp change of strike at the axis of the deep syncline Probably no important faulting exists in that area

9 In the Reading Railroad cut east of Birdsboro station (on the Schuylkill River midway between Pottstown and Reading) there is a fine exposure of a fault It is the only one the writer has seen which might be called a thrust The strike is northwest, the dip steep northeast, and drag shows that the upthrow was on the northeast side It strikes directly toward a conspicuous offset of the diabase sill two miles to the northwest, but a connection is not established

THE SCARCITY OF FAULTING IN THE NORTHERN DELAWARE RIVER SECTION

Probably the most significant result of this study is not the recognition of previously unknown faults and of groupings of disturbed outcrops, but the demonstration that there are large areas in which a thorough examination has failed to reveal evidence of appreciable disturbance The best exposures in the region are those along the Delaware River from Lambertville to the north border That section has been studied in great detail by the writer, and equally close attention has been given to the splendid section along the

deep gorge of Tohickon Creek Large disturbances near the Flemington fault north of Lambertville have already been noted, and a region of intense faulting and shearing has been shown to exist near the north border above Frenchtown and Milford But in the section between, except for a few slight disturbances which are recorded on the map (Fig 2), there is an evident dearth of faulting throughout the 12,000-foot column from the base of the Stockton formation to the sill of traprock which caps the plateau west of Frenchtown

Faults have a way of hiding themselves No claim is made that minor faults do not exist where none have been found In the best sections there are covered stretches where small dislocations may lie concealed. But when recognizable strata are present, the magnitude of the offsets which could escape detection is definitely limited That is the situation in large parts of the Delaware River and Tohickon Creek sections, the details of which will form the subject of a future paper A number of interbedded red- and black-shale members have been identified in that region, and have been traced for some miles along the strike Except for the apparent cutting out of a member for a short distance (as noted under "Smaller Disturbances," section 4) there is no indication of faulting which would materially affect the calculation of thickness of the series The principal cause of uncertainty lies in the limits of accuracy with which the angle of dip can be measured

RELATIVE AGES OF FAULTS

Downfaulting at the north border must have begun early in the Newark period, if not just before, and it probably continued intermittently to the end of the deposition Near the close of the period the diabase dikes and sills were intruded, these were associated with some dislocation, as is shown by the repetition of the base of the Triassic south of Reading, where a fault is occupied by a large dike, and by the continuation of the traprock along a fault through a considerable part of the series Finally, after the intrusion and some subsequent sedimentation, large fractures were formed across the basin, then the major blocks were tilted to produce the threefold outcrop of the stratigraphic column in the Delaware River section Probably at the same time additional movement occurred along the north-border faults, and numerous minor dislocations were produced in the rocks adjacent to the boundary, as they are exhibited near Milford, New Jersey

SUMMARY

Minor faults and outcrops which show other evidence of faulting are not scattered indiscriminately throughout the Triassic rocks They cluster strongly along the major fractures that cross the area and near the north border A few previously unknown possible faults are indicated by alignments of disturbed exposures In the central northern part of the Delaware River section a detailed examination has revealed only a few slight evidences of dislocations, and the effect of unknown faults upon the calculated thickness is considered to be negligible

UNIVERSITY OF MICHIGAN

ANTHROPOLOGY

NOTES ON CREE MEDICINES, BASED ON A COLLECTION MADE BY I COWIE IN 1892

GRETCHEN BEARDSLEY

DR PAUL MARTIN, curator of anthropology, Field Museum, Chicago, Illinois, in 1934 sent to the ethnobotanical laboratory of the Museum of Anthropology, University of Michigan, a collection of plant materials and field notes obtained by a certain Mr I Cowie in 1892 from the Cree Indians living in the Northwest Territories, Canada[1] Mr Cowie traveled through this region just prior to the Columbian Exposition in 1893 There is no information available to explain further who he was or for what specific purpose the journey was undertaken and the collections made

There are eighteen lots of fragmentary plant materials, several mixed with crumbled bone or with mineral-like substances or with both No entire plant is included, leaves, bark, stems, and roots being broken into small pieces or finely pulverized Identification of the plant represented was made when possible The fungi were identified by Dr D V Baxter, associate professor of forestry, University of Michigan, and Dr A H Smith, associate curator of fungi, University Herbarium, the phanerogams, by Mr V H Jones, assistant curator of ethnology, Museum of Anthropology, by Mr A F Whiting, onetime graduate student in anthropology and botany at the University, and by the author Five lots are so finely powdered that no satisfactory determination could be made

The collection is a heterogeneous sampling of medicinal, smoking, and food materials Of these, the medicinal predominate and will be discussed fully later on Five lots represent plants used for food or for smoking These are listed in Table I, but are not treated in this paper

A complete discussion of Cree medicines and practices is not attempted, but examination of available literature treating the Cree

[1] Acknowledgment is due Dr Martin for making the material available and for permission to publish the notes

TABLE I

PLANTS COLLECTED AMONG THE CREE INDIANS BY I COWIE IN 1892

Catalog no	Cree name	Scientific name	Common name	Cree use
14043	*Muskeg mueng*	*Ledum groenlandicum* Oeder	Labrador tea	For burns, scalds, as emetic; for tea
14044	*Pak am oos i kun* *Pas kus i gun ah tick*, 'gunstick' *Kah pe mun ah mug*, 'the twisting root'	Unidentified		As emetic
14045	*Kee poo ćus i ćun*	*Cirsium discolor* (Muhl) Spreng.	Common thistle	As styptic
14046	*Che pay ćoo pee*	Unidentified		As emetic
14047	*Pick quan ah tick*, 'wild parsnip'	*Heracleum lanatum* Michx.	Cow parsnip	For toothache, boils, chancres, to reduce swellings, as poison for arrows and bullets
14048a	*Meah kis igun* *Amisk we tway* *Wus tu kay pib* *Ka kus ke tay wak oochay pick*, 'bear root' *Wah chink wook as newsoo win* *Ay eah pah was tay r* *Apis sah quay wis koos*	Unidentified		For headache
14048b	*Aske onus ka ka*, 'earth medicine' *Kah onus ah sah*, 'water plant' *Pak kan ic k*, 'nuts' *Ka quak oo taik*, 'a blazing thing'	Unidentified		For delirium, as antidote to poison

14049	*Meah kis igun*, 'red touchwood'	*Echinodontium tinctorium* E. and E.	Fungus	As styptic, as emetic
14050a	*Pays coomina*, 'pepper' (?)	Unidentified		For chancre, bubo
14050b	*Wap in oo ke ke*, 'Saulteaux medicine man's medicine'	Unidentified		For earache, sore throat
14051	*Sah quay wisk*	Unidentified		For amenorrhea, to prevent childbearing
14052	*Wah pak toos*, 'white arrow'	*Fomes officinalis*	Fungus	For frostbite
14053	*Mech quah too*, 'red touchwood'	*Fomes pinicola* (Swartz) Cooke	Fungus	For wounds, as emetic
14054	Not recorded	*Allium cernuum* Roth	Wild onion	For food
14055	Not recorded ('red willow')	*Cornus stolonifera* Michx.	Red osier	Bark mixed with tobacco for smoking
14056	Not recorded	*Arctostaphylos Uva-ursi* (L.) Spreng	Bearberry	Leaves mixed with tobacco for smoking
14057	Not recorded ('white-bear willow').	*Eleagnus argentea* Pursh	Silverberry	Berries for food, wine, bark for cordage, seeds for beads
14058	*Mutoos*, 'white,' or *mee-toos*, 'rough' or 'black'	*Populus grandidentata* Michx.	Large-toothed aspen	To prevent childbearing
14059	Not recorded	Unidentified	Wood carrot	For food
14060	*Kah pus kun askik*	*Grindelia squarrosa* (Pursh) Dunal	Gum plant, tarweed	For gonorrhea, to prevent childbearing

Indians indicates that there are few duplications of Mr Cowie's findings, and for this reason the author believes they merit consideration The symptoms and cures recorded by Cowie are noted here, and used as a basis for comparison with data already recorded concerning the Cree and their immediate neighbors

The field notes[2] are presented in Table I, where the plants are listed according to Cree name, scientific name, common name, and Cree use In the discussion they are treated with reference to particular diseases — digestive disorders, wounds, respiratory complaints, and the like

MEDICAL PRACTICE AMONG THE CREE

In order to evaluate the significance of Cowie's materials we must briefly consider the attitude toward medicine and the practice of it among the Cree, and also note the influence of neighboring groups on this aspect of their culture

The Cree were essentially a forest people, whose range extended from the vicinity of Hudson Bay west and north to Lake Athabasca and south to the Red and Saskatchewan rivers Many of the groups were nomadic and in their wanderings came in friendly contact with the Saulteaux, or Ojibwe, who lived along the northern edges of the Great Lakes, and with the Maskegon,[3] also known as the Swampy Cree, around the Red River The abundant supply of buffalo attracted them to the plains, as well, where they encountered the hostile Blackfoot and the Sarsi in the west and the Dakota and the Crow in the south and southwest Of the several groups with which they mingled, the Ojibwe, closely related to them linguistically and in mode of living, most influenced their medicinal practices and beliefs

The Indians thought that all sickness was brought about by supernatural forces It was an instrument of revenge and punishment used by malevolent spirits and evil persons who desired to harm somebody because of a broken taboo, an insult, a bodily in-

[2] Cowie's notations, were added to, as indicated by a difference in handwriting by someone who probably examined the materials after they had been deposited in the Field Museum

[3] A short article by C Flexion, "Some Medicines of the Swampy Cree of the North" (*Can Pharm Journ.*, 31 126–129, published in Toronto in 1897–98), may be of value for future studies. The author was unable to obtain a copy, so no further reference is made to it

jury, or out of jealousy Wicked spirits were believed capable of inflicting an ill directly upon a selected victim, whereas humans solicited aid from powerful shamans, who in turn communed with the spirit world Such practices were frowned upon by the group as a whole, but "bad medicine" was indulged in by a few, who professed to be well versed in spirit activities

Many individuals indulged in intercourse with supernatural beings, and certain of them were known to have special gifts and powers Shamans, as has been said, were regarded as intermediaries By virtue of special instructions received in visions and by purchase from older men they plied their arts for both good and ill, subjecting the people by playing upon superstitions

There were several gradations of shamans among the Cree jugglers, prophets, and sorcerers In general medical practice a shaman often utilized the skills of all three and was aided by assistants with bells, rattles, drums, incantations, and prayers to inspire and awe the patient and his relatives Curing was regarded as a prime blessing and a noble calling It could be accomplished only if a shaman's spirit helpers were stronger than those of the being who caused a person to be afflicted A patient might be treated either by a conjurer, whose duty it was to charm away the evil spirits which haunted him, or by a medicine man, whose practices were only curative

Among some groups a medicine man did not adopt his profession by choice He received a "call" from the spirit world If he were thought to have been instrumental in saving a life he then undertook the responsibility, and henceforth maintained the secrecy, of this profession (8, p 339) A shaman among the Plains Cree might be greatly respected for his ability, but his social and material position was not noticeably altered because of this distinction

Medicine men performed other duties than those associated with medicine They occasionally "sang to the spirits" (9, p 258), asking for good weather, and they dispensed hunting and love charms The latter were considered a Saulteaux specialty, and few of the Cree made them. Mandelbaum (9, p 255) states that the Plains Cree obtained most of their information from the Saulteaux and whenever possible called upon Saulteaux medicine men to effect cures However, they regarded the Saulteaux and Wood Cree "as 'bad medicine' men who fought by magical means rather than by

strength of arms Hence care was taken not to offend visitors from these tribes and their company was not sought "

Central Algonquian and southern Siouan tribes formerly had medicine societies, based upon similar principles, which strongly influenced the activities and beliefs of the peoples The Midewiwin was the most complex and elaborate of these (7) Skinner (10, p 12) suggests that the ceremony of this society was probably of Ojibwe origin, since Algonquian songs persisted among the Siouan peoples and since other Algonquian groups, such as the Potawatomi, the Cree, and the Menomini, regarded the Ojibwe as "the great authority on the ritual "

The Cree of the Hudson Bay region had a secret society, the Mitawin, which taught "medicine, religion, and secret methods of communication" (12, p 736) Candidates for the society began their training as youths After receiving favorable visions they were instructed by the older men of the group They first learned how to diagnose various ailments This skill was all-important, for they believed that effective curing depended upon a proper diagnosis Before proceeding with a cure a medicine man would attempt to ascertain the possibility of the patient's recovery by placing a small amount of powdered club moss, *Lycopodium sp* , in a vessel of cold water The powder is insoluble and remains inert for a few moments, then suddenly radiates out in a spokelike manner If the movement was in the direction of the sun the patient was expected to recover, if in the opposite direction, he would die For each disease a specific medicine in the form of an infusion, decoction, or powder was given Only rarely did the Cree use more than two drugs in combination The Ojibwe, however, were noted for their complex compounds Their "sixty-two medicine" (4) is a single example of their elaborate pharmacopoeia Plants were combined or used singly

After a candidate had learned to distinguish the various types of bodily afflictions and to compound medicines he was ready to begin practice for himself Each novice received, at the end of his training period, a birch-bark document which was a combination anatomical chart and pharmacopoeia, for on it was drawn in red ocher a life-sized human figure, with the organs in their proper position and an arrow from each to the edge of the chart, where a piece of root or powder wrapped in birch bark was attached "The exact

dose specific for that particular organ when affected by any trouble is clearly set forth" (12, p 742) The Ojibwe recorded their songs and ceremonial directions on birch bark and the Dakota used wooden paddles for this purpose, neither, however, had anatomical charts, which are unique so far as the author knows, among the Cree of the Hudson Bay area

According to Deniz (2, p 315), knowledge of herbs and their properties was confined entirely to doctors Harmon (5, p 318), on the other hand, says that almost every male had a medicine bag, which was sacred and taboo to women Women also had medicine bags, but these were not considered untouchable

The use of medicine for its inherent values was generally incidental The "spirit" which the remedy contained procured the desired results Poisons were known and employed, but they were considered dangerous, and novices were not taught specific applications for them until their training was about completed.

Minor ailments, such as cuts, slight wounds, and the like, were treated with simple natural remedies If the illness seemed serious or the wounds severe the shaman called upon all his skill to aid him Generally he first solicited the aid of his spirit helpers The medicinal procedure depended upon the vision he received If there was some doubt of recovery the shaman would not promise a cure until success seemed certain

On the whole, knowledge of anatomy was decidedly lacking The Western Cree recognized two sets of "veins," one (vein) which stopped bleeding of its own accord, and the other (artery) which needed to be bandaged in order to stop the blood flow (9, p 315) As a means of reducing fevers, arm or leg veins were opened with a sharp flint or arrow point tied to a stick "Cupping" was accomplished by applying short bone tubes to the infected area and drawing the poison out by sucking (1, p 534)

The use of sweat houses was universal A circular structure made of bent willows and covered with skins or bark was built near a stream, and heated stones were placed in the center The patient, closing himself in, dashed cold water over the stones and after a thorough sweating took a quick swim in the cold water or rubbed himself with snow Febrile symptoms, chronic rheumatism, headache, fast pulse, catarrh, and sore muscles were generally treated in this manner

Apparently only women assisted at childbirth, though men doctors sometimes prescribed certain decoctions if the case was a difficult one (9, p 317) Further than this, women generally confined their activities to simple home remedies and to helping their husbands effect cures

Failure might be laid to several causes Supernatural powers could be blamed, or the patient's transgressions may have been too grave for the shaman's spirit helpers, or, again, evil influences may have been at work too long before aid was sought The shaman sometimes accused the patient's relatives of neglecting the proper ceremonies and offerings These alibis were generally resorted to as a means of self-protection, for the family of the deceased, if they felt the doctor was directly at fault, might seize his property or even put him to death (2, p 313)

As a rule, medical attention was given in proportion to the fees paid in advance The initial gift was usually a sizable one if continuous attention was needed, and the shaman's wife was often included in the offering since she sometimes assisted in the treatment Frequently the patient was encouraged to believe that if high payments were made, even such as would reduce him to poverty, he would receive supernatural blessings This being so, it is no wonder that dire results generally followed a failure and that the doctor must needs put on a convincing show

The brief discussion above of the practice of medicine by the Cree presents a broad picture of its position in the culture of the group As will be seen, Cowie's findings and the comparative data fit into this general pattern, and are not merely scattered and unrelated notes

SPECIFIC AILMENTS AND THEIR REMEDIES

Excessive Bleeding

The Cree used several plants as styptics A fungus, *Fomes pinicola* (Swartz) Cooke (Cree *mech quah too*), was dried and pulverized, and the powder was mixed with water to make a paste, which was applied to the wound. Another fungus, *Echinodontium tinctorium* E and E. (Cree· *meah kis iqun*), was also used Cowie did not state just how it was prepared, but probably as was the first Roots of the common thistle, *Cirsium discolor* (Muhl) Spreng. (Cree *kee poo ćus i ćun*), were prepared in a similar fashion, the wet paste

being spread on linen cloths and bound onto the wound Strath (12, p 738) reports several methods of treating excessive bleeding employed by the Cree of the Hudson Bay region An infusion of the powdered rhizome of cohosh, *Caulophyllum thalictroides* (L) Michx, was taken internally, or about thirty grains of the dry powder was allowed to dissolve on the tongue Freshly peeled willow bark, *Salix nigra* Marsh (Cree *sepastikoos*), was applied as a dressing to severe wounds, and sutures of willow bark which had been scalded in water were used to draw the edges of the wound together Sometimes a tourniquet was employed For internal hemorrhage leaves of plantain, *Plantago sp* (Cree *muskosia*), were chewed and swallowed, and for post-partum hemorrhage an infusion was made from cohosh, the "scum" collected from infused hemlock, and six other plants, which the author did not know.

Frostbite

Frostbite was treated with a powdered fungus, *Fomes officinalis* (Cree *wah pah toos*) The swollen parts were first scarified, and then the pulverized fungus, spread on linen, was bandaged in place The Plains Cree (9, p 258) likewise scarified frostbitten hands and feet After pricking the affected areas with a sharp bone they rubbed medicinal alkaline salt or snow into the scratches and then packed snow around the frozen parts

Earache

A packet (Cat 14050b) containing powdered plant material which was not identifiable (Cree *wap in oo ke ke*) was reported to be a cure for earache The fine powder was to be mixed with one-fourth teaspoon of water, put into the aching ear, and a plug inserted to retain it The translation, "Saulteaux medicine man's medicine," of the Cree name suggests that this remedy may have been obtained from the Saulteaux The Cree of Hudson Bay used plantain leaves, *Plantago sp*, for earache (12, p. 740)

Toothache

For toothache Cowie reports that a small piece, about one-half inch square, of the root of cow parsnip, *Heracleum lanatum* Michx. (Cree *pick quan ah tick*), was held on the sore tooth Saliva was spit out as it collected, for the plant was known to be poisonous.

According to Strath (12, p 740), the Cree of Hudson Bay chewed the leaves of plantain, *Plantago sp*, to relieve the aching

Headache

Seven unidentifiable plants (Cat 14048a) were combined in powdered form for children's headache One-fourth teaspoon of the powder mixed with a little water was smeared on hot stones, and the patient, with head covered, inhaled the fumes

Sore Throat

Swollen sore throat was treated with the same remedy used for earache (Cat 14050b) About two grains of the powder were held in the mouth and the saliva swallowed

Boils and Swellings

The root of cow parsnip, used also for toothache, was powdered, stirred into a paste with water, and spread on a linen cloth as a poultice for boils and swellings, or the powder was mixed with lard and applied as an ointment The Chippewa (3, p 351) called this plant *bi'big we'wûnûck* and used it for the same purpose They prepared it in two ways (1) by boiling the root and employing it as a drawing poultice and (2) by applying the dried and pulverized root and flowers without moisture Smith (11, p 390) reports that the Pillager Ojibwe called the cow parsnip *pi'pig we' wanûck*, 'flute stem,' and used the fresh, pounded root to poultice sores

Burns and Scalds

Burns and scalds were poulticed with an ointment made of powdered leaves of Labrador tea, *Ledum groenlandicum* Oeder (Cree *muskeg musrig*). The "Outchipwai" Indians (1, p 536) applied the chewed leaves of this plant to wounds and skin affections The Cree of the Hudson Bay region prescribed chewed leaves of plantain, *Plantago sp*, for burns and scalds, and they also made an antiseptic powder from the foliage The Flambeau Ojibwe (11, p 380) soaked the leaves of *Plantago major* L. (Ojibwe *cua' gû ski bûge sink*, 'leaves grow up and also lie flat on the ground') in warm water and bound them on bruises, sores, and sprains The Pillager Ojibwe (11, p 380) used the leaves of this plant, which they call *jimûcki'-gobûg*, in the same manner

Scrofulous Glands

The Hudson Bay Cree (12, p 741) made a poultice and an infusion, to be taken internally, of the rhizome of dock, *Rumex sp* (Cree *tatupewewewutupe*) The two were used in combination to cure scrofulous enlargement of glands

Ulcers and the Like

Mandelbaum (9, p 258) reports that the Plains Cree wash wounds with buffalo hair dipped in water in which medicine has been dissolved The powdered rhizome of false indigo, *Baptisia sp* (Cree *chepatakwawutupe*) was prescribed to dry up sores and used locally in doses of from five to twenty grains for ulcerated surfaces (12, p 737) Smith (11, p 38) says that the bark of hemlock (Chippewa *ga ga gi'wic*, 'raven tree') acted as a styptic to heal cuts and wounds

Ailments Requiring Emetics

One-half teaspoon of the dried and powdered fungus *Fomes pinicola* (Swartz) Cooke was steeped in one-half pint of water and given internally in ailments requiring emetics Another fungus, *Echinodontium tinctorium*, was also used for this purpose and was probably prepared and administered in the same fashion One packet (Cat 14044) contained three plants which were so pulverized that they could not be identified but which were said to be used as an emetic, equal parts of powder and water being infused to make two doses for an adult Two root fragments (Cat 14046, Cree *che pay too pee*) about the size of hickory nuts were to be pulverized and infused in a cup of water for three doses for an adult If an equal part of common salt was added the effect was greatly increased Rhizomes of false indigo, which was a remedy for ulcers, also, were used by the Hudson Bay Cree in bulk or in powdered form as an emetic (12, p 737)

Kidney Trouble

Diuretics, too, were known, for Cowie reports leaves of Labrador tea in an infusion. According to Strath (12, p 741) several plants were employed by the Hudson Bay Cree for this purpose, dried and powdered bark of black willow and rhizomes and rootlets of catbriar, *Smilax sp* (Cree. *mikwawutupe*), were used, but no method

of preparation or administration has been described. After it had blossomed, the common dandelion, *Taraxacum sp* (Cree *meweweuineow*), which had been introduced from Europe, was pulled and the milk pressed out An infusion was then made from the roots and given in copious draughts at hourly intervals An unidentified person, who perhaps examined Cowie's collections, added to his original notes the information that camomile, *Anthemus sp*, was combined with tarweed, *Grindelia squarrosa* (Pursh) Dunal (Cree *kah pus kun askik*), to treat pains in the kidney

Menstrual and Delivery Pains

Infusions of poplar bark, *Populus grandidentata* Michx (Cree *mutoos* or *meetoos*), or of the buds and flowers of tarweed were given to ease and lessen the menses If over some time either was taken just before each period, the flow would soon cease entirely An unidentifiable root (Cat 14051, Cree *sah quay wisk*) was dried and powdered, and a pinch was taken internally to cure amenorrhea If women did not wish to bear children they chewed a bit of the root regularly each month Strath (12, p 380) reports that the Hudson Bay Cree used the rhizomes, roots, and flowers of cohosh, *Caulophyllum thalictroides* (L) Michx (Cree *iskwawutupe*, 'women's root' or 'squaw root'), as an abortive The Pillager Ojibwe (11, p 358) called the cohosh *oci'gimic* and used the roots for general female troubles, especially for stomach cramps during painful menstruation

Venereal Diseases

Venereal disease was treated in several ways For chancre, powdered roots of cow parsnip, which was also prescribed for toothache and boils, were mixed with water and applied wet on linen cloths or blended with lard to make an ointment One packet (Cat 14050a) contained several unidentifiable materials (Cree *pays coo mina*), said to be three kinds of white medicine and various Indian medicines, which were used for chancre and bubo For the former a small quantity of the powder was dusted on the prepuce once or more often until a cure resulted For bubo five grains of the powder were mixed in water, the abscesses were opened, and the fluid injected with a syringe An infusion of *pays coo mina*, 'pepper' (?), and brimstone was taken internally at the same time This treatment was continued until the patient was cured The Cree of

Hudson Bay (12, p 745) gave large doses of *Baptisia sp* mixed with several other plants for strictures caused by gonorrhea Blood purifiers and strong purgatives were generally prescribed for syphilis Several plants were used for chancre the sores were dusted with the powdered rhizomes of false indigo, *Baptisia sp*, washed with a warm decoction made by steeping willow bark, *Salix sp*, and spread with a salve prepared from spruce gum, *Picea sp* Rhizomes and rootlets of catbriar, *Smilax sp*, were combined with false indigo for syphilis

Madness

A mixture of Indian and white drugs (Cat 14048b) containing powdered human skull, alum crystals, and several other materials bound up in a small piece of buckskin was said to be an antidote for an Indian poison which produced madness The scalp was scarified at the brow, crown, and nape of the neck, and one third of a gram was inserted in each incision The fumes of the powder were also inhaled This medicine was used only for adults

Cowie's collections, for the most part, indicate that the Cree and their neighbors were acquainted with and used the same group of plants in a similar manner

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TENSE, ASPECT, AND MODE IN THE AKLAN DIALECT

HELEN W BLACK *

AKLAN is a dialect of the Bisayan group of Philippine languages, localized in a valley between two rivers in the north of the island of Panay [1] The present paper, on tense, aspect, and mode in Aklan, will not attempt to deal with any acculturation which may have taken place, though incidental comparisons with Tagalog and Cebuan (another Bisayan language near by), and, of course, with English and Spanish, reveal a sort of lexical communism There are enough complications and irregularities to raise the question of borrowing, but so far the study of Aklan has been confined mainly to description Here we will be concerned only with analyzing the principal features of the verbal system, and that simply as regards the most frequently used infixes and affixes

Such terms as "tense," "mode," and "verbal system" do not necessarily imply that there are in this dialect elements which are verbs per se, we need only assume that there are roots combined with certain morphemes in a system which yields usages as truly verbal as those of English None but sentences like the more familiar English types have been drawn upon for evidence

Inasmuch as the words "aspect" and "mode" mean something different virtually every time they occur, it may be well to state at the beginning the sense in which they will appear here "Tense," of course, refers to any formal modification of the form serving as a verb, in order to locate it in some segment of time "Aspect" indicates any such modification for the purpose of singling out a phase of the action — for example, duration, beginning, ending, fre-

* The author is greatly indebted to Professor Albert H. Marckwardt, who secured the informant, Mr Alfredo Morales, and who started and supervised the work. He made many suggestions and clarified numerous points, both during the study and after reading the first draft

[1] See Ryder, Frank G., "Variant [γ] in the Aklan Dialect of Bisayan," *Pap Mich. Acad Sci, Arts, and Letters*, 26 (1940) 573–574 1941

quency — with no regard for the actor "Mode" designates the class of devices by which the speaker contrives to place his interpretation on the action he is reporting, by which he labels it fact or probability, or by which he fixes the blame for it

Most imposing is the list of elements which may be considered to indicate tense *Naga* (abbreviation, *ga–*) is present active, with a companion passive, *gina* (no abbreviation) These preposed formations may or may not appear with the root as one phonetic word Person is indicated by the subject, which can also show number The subject takes the particle *ro*, as distinct from the object or the agent, which are preceded by *ko*

naga-*itsa* *ko* *batog* *ro* *ong̃a*[2]
throws the stone the child
The child throws the stone

gina-*itsa* *ko* *ong̃a* *ro* *batog*
is thrown by the child the stone

Corresponding past-tense forms, when a distinction is desired, are furnished by *nag* (active) and *gin* (passive).

nag-*kaγud*[3] *ro* *ajam* *ko* *anang̃* *likud*
scratched the dog the his back
The dog scratched his back

gin-*kaγud* *ko* *ajam* *ro* *anang̃* *likud*
was scratched by the dog the his back

gin-*baligja*-an *ro* *bayaji* *ko* *bendero* *ro* *saging̃*
was sold it the woman by the vendor the banana
The woman was sold the banana by the vendor

The suffix *–an* is a cross reference to the goal of the action and is used with *gina*, as well as by itself[4] Alone, it is associated with present time.

adton-an *na*
go there by him
He is going there

[2] *ng̃* is a spelling for the velar nasal The orthography common in the Philippines for velar nasal followed by velar stop is *ng̃g* or *ngg*

[3] γ is a velar or palatal fricative, which interchanges with *l*.

[4] This element, obviously secondary, is mentioned only because of its parallel *–un* in the future (see p. 500)

A favored form, which is elicited when no stress is laid on the time of the action or when an event is narrated, contains the morphemes *-um-* (active) or *-in-* (passive) These are infixes when the root begins with a consonant, prefixes when it begins with a vowel The latter, *-in-*, may be accompanied by the *-an* mentioned above

si Berta	um-*abut*	*kahapon*
Bertha	came	finally

b-um-*oʔog*	*sanda*	*it*	*kagat*
got	they	a	rope

in-*osoj*	*nanda*	*si*	*baʔo*
was looked for	by them	the	turtle

b-in-*uhi*-an	*nanda*	*ru*	*pispis*
was set free it	by them	the	bird

The root alone, if it lends itself to such a construction, may be used in generalizing statements of fact.

ro	*γanĝgam*	*owaʔ*	kaʔon	*ko*	*ajam*
the	rat	not	eat	by the	dog

Rats are not eaten by dogs

ro barjo it Mabilo	anĝaj	*karondojonĝ*	*eskojlahan*
the district of Mabilo	deserves	this	school

For any but future events a prefix *na-* serves to indicate the fact of becoming or being made into something

raj	*baʔo*	na-*buhi*
the one of the	turtle	came alive

na-*akig*	*ro*	*hari*
got angry	the	king

na-*tapus*	*ni*	*Hwan*	*ro*	*sugiranun*
gets finished	by	Juan	the	story

Juan is finishing the story

An element *ga-* performs the same function for future actions

ga-*puγa*	*ako*
will get red	I

Another way of locating actions in the future is furnished by *ma-*, which fills out the active series

ma-*ka?on*	*ako*	*it*	*saging*		ma-*sinĝgit*	*ako*
will eat	I	a	banana		will shout	I

Or the future may be indicated by *-un*, which is passive, like *gina* and *gin*

ka?on-un	*ni*	*Pedro*	*ro*	*saging*
will be eaten	by	Pedro	the	banana

On the basis of these facts it would seem that Aklan has three rather clear-cut tenses, past, present, and future, with provisions for some sort of active and passive voice throughout Actually, there emerges a picture more truly represented by the table

Time of action

Happened		*Now happening*	*Not yet started*	
nag		naga	ma-	
gin		gina	-un	
na-			ga-	
na-	-an		*ga-	-un
-um-, *root*				
-in-, *root* + -an				

The tenses that can be pinned down are oriented about a present which corresponds, not to the time at which the utterance is made, but to the time at which the action being discussed or reported takes place This becomes immediately apparent when one discovers in a story told as of past time such sequences as

tag	naga-*tuγug* (present)	*si Hwan,*	*b*-in-*uhi-an* (past)	*nanda*	*ru*	*pispis*
while	is sleeping	Juan,	was set free	by them	the	bird

Moreover, in the next sentence but two comes

nag-*kasògut* (past)	*sandanĝ*	*tanaw?*un (future)	*kun*	*ano*	*ro*
agreed	they that	will be seen	if	what	the

suγùd	*ko*	*bubùn*
contents	of the	well

They agreed to see what were the contents of the well

There is, of course, the possibility that narrative style shifts the

main action to the present, but the *nag* and *gin* forms can be elicited as past in opposition to those with *naga* and *gina*, it has not been possible to elicit pluperfect or future perfect forms different from those used as past and future

There is in addition a factor of aspect that makes it impossible to class the constructions with *na*– and those with infix under either past or present exclusively The latter constructions (infixed) are essentially aoristic in that they denote an action viewed as a whole, no matter what its duration or when it occurs — provided, of course, it does occur and is not merely predicted

t-in-*aw-an*	*si Hwan*	*it*	*γubid*
was given	Juan	a	(piece of) string

b-in-*uγun*	*ro*	*anang̃*	*mang̃a*	*nina*
were healed	the	his	many	wounds

s-um-*unud*	*imaw*	*kakun*
comes after	he	me

This is true also, apparently, of constructions with *nag*

si	*baʔo*	nag-*bantay*	*sa*	*punu*
the	turtle	waited	at the	base of the tree

nag-*tabo*	*sanda*	*sa*	*sang̃ka*	*bubun*
came together	they	at	a	well

The two formatives in combination, however, yield a progressive

nag-*k*-in-*aʔun*	*si*	*amo*
kept eating	the	monkey

The monkey kept eating

As for *na*–, it emphasizes the beginning or inception of a state, as opposed to the fact of being in one (see p 499 for examples)

These borderline instances shade into others which are more purely aspect *Ka*– expresses the fact of being in a state or condition, at any time

ka-*baliʔ*	*ro*	*prinsipe*
was returned	the	prince

The prince was back

owaʔ	ka-*samit*	*si*	*baʔo*
not	did taste	the	turtle

The turtle didn't taste (it)

indiʔ	*ako*	ka-*saka*
not	I	(can) climb

An infix consisting of *l* or *γ* plus a vowel which repeats the vowel of the syllable in which it finds itself occurs when it is desired to indicate the existence of a number of similar actions at the same time or in the same place [5]

ro	*XIX*	*n̄ga*	*na*-γa-*mataj*
the	nineteen	who	died together

ha-γa-*mbal*[6]	*sanda*	*u*-γu-γo-*soj*	*sanda*
are discussing	they	all looked	they

The situation is further complicated by considerations of mode The aoristic *–um–* forms appear as imperatives, as do the *ma–* forms, along with the regular imperatives (which merely add *–i* or *–a* to the root)

ma-*gaba*	*ka!*	*k*-um-*aʔon*	*ka*	*it*	*saging̃*
wash	you!	eat	you	a	banana

And, finally, quite free from connotations of tense, are three other modes The first, one of *unintentional action*, takes a formative *ha–*

ha-*huγug*	*ni*	*Maria*	*ro*	*γapsag*
is accidentally dropped	by	Maria	the	baby

The second is a *causative* mode, expressing action produced by pressure exerted on the actor, with an element *pa–*

b-in-asahan	*nana*	*imaw*	*it*	*sugiranun*	*paran̄g*	pa-*tuγug*
was read	by him	she	a	story	to	make (her) sleep

He read her a story to put her to sleep

The third mode is like that called "contingent" by Bloomfield in

[5] A case could of course be made for considering this a rudimentary pluraliser, but there are parallel nouns, *ka*-γaγa-*ʔon*, 'feast,' i-li-*sdaʔatan*, 'fishing place,' *a*-γa-*gijan*, 'passageway,' *ka*-γa-*ʔonon*, 'edibles,' which seem to point in the other direction There is also the favored sentence form, which puts the verb first By this, and by the lack of stress on any word preceding the verb in the phrase, emphasis is laid on the action rather than on the actor

[6] *Hambal*, 'talk,' 'speak'

his Tagalog grammar[7] It appears when the event referred to is patently unreal or when the speaker wishes to imply that it is probably not true Negatives in a sentence do not necessarily mean that this mode will be used Any constructions but those with the *nag*, *naga*, *ma-*, *gin*, *gina*, *-un* series may occur in negative sentences These formatives must be replaced by *mag-* (active) or *gi-* (passive)

indi? *ro* *pispis* mag-*kanta*
not the bird would sing
The bird refused to sing

kun *gustu* *nanĝ* mag-*tanaw* *sa* *prinsesa*
if wanted by him to see the princess
If he wanted to see the princess

ro *ajam* *owa?* gi-*tawi* *it* *tuγan* *ko* *tawo*
the dog not is given a bone by the man

If it is desired to locate in time the things expressed by these rather fluid mode and aspect formations, they may be combined with the more definite elements With the exception of *mag-* and *gi* - practically any two or three of them can appear in conjunction Thus we find

nag-pa-*kita* *sanda*
made seem they
They represented themselves

na-ha-*adto* *rito* *ro* *Presidente*
got lo! went there the President
The president entered into a state of go(ing), not on purpose

nĝa k-in-a-*hadluk*-an *it* *manĝa* *tawo*
who was in a state of being feared by many men

nĝa na-gin-*batog*
who became made stone

The whole system, then, could be schematized in the following way.

[7] Bloomfield, Leonard, *Tagalog Texts with Grammatical Analysis*, University of Illinois Studies in Language and Literature, Vol. 3, No 2 Urbana, 1917

Time of action

	Happened		*Now happening*	*Not yet started*		
			ha-			*Mode*
			pa-			
			mag [8]			
			gi [8]			
Time	nag		naga	ma-		
	gin		gina	-un		
	na-			ga-		*Aspect*
	na-	-an		[9] ga-	-un	
	-um- [9]		*root*			
	-in-		*root* + -an			
			ka-			
			-l, γ + *vowel-*			

Complex as this presentation appears, with the overlapping of functions shown on the table, it is a simplified statement of the situation Aklan demonstrates vividly one way of attaining subtle distinctions without the use of inflections But the unusual feature is its retention of formal mechanisms for all three of the verb modalities, in contrast to most of the better-known languages, which have only two

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[8] These do not combine with any other formatives
[9] These have at times modal function, as imperatives

CACHES OF PREHISTORIC ARTIFACTS DISCOVERED IN SAGINAW COUNTY, MICHIGAN

FRED DUSTIN

THE present paper, on caches of prehistoric artifacts found in Saginaw County, Michigan, deals with hitherto unreported discoveries It was prepared in part from notes made years ago My thanks for recent information are due to Mr Ralph Stroebel, Mr Henry Bornhoff, and Dr R M Kempton, all of Saginaw, Michigan

On May 12, 1926, three boys, Arthur and Arno Seidel and Son Glunie, while playing on the Andrews Village site, NW ¼ Sec 32, T 12 N , R 4 E , about sixty rods west of the Michigan Central Railroad and the same distance from the Tittabawassee River, noticed some arrow points slightly exposed in the dredge cut made by a sand excavator They dug them out, and found that they numbered 173 triangular points measuring from one and one-fourth to two and one-fourth inches long, and made of brown chert Triangular arrow points are scarce in this region, as is brown chert, although two acres of ground a mile southeast on the opposite side of the river are strewn with brown chert flakes, and an occasional arrow point of that material is collected there It seems that the cache which the boys found was a hidden store, to be drawn on as needed by the owner Mr Ralph Stroebel named this the Kinney cache Unfortunately it was broken up, each of the boys taking a third of the points

As I have previously noted,[1] the Fraser mound site is remarkable for the number of caches found Mr Harlan I Smith,[2] who incorrectly spelled the name "Frazier," reported two, and at least four others have been discovered since The Fraser Village site lies east

[1] "A Notable Prehistoric Village Site in Saginaw County, Michigan" Unpublished MS, read before the Anthropology Section, Michigan Academy of Science, Arts, and Letters, March, 1938

[2] "The Saginaw Valley Collection," Suppl to *Am Mus Journ.*, Vol 7 (1901), No 12

of the west Tittabawassee River Road, between it and the river, and south of Highway M-46, locally called the "Gratiot Road," and covers about forty or fifty acres On May 9, 1910, Mr Harry W Armstrong, while plowing on the northerly part of this site, turned up a cache of sixty-six finely chipped leaf-shaped blades, nearly all about five and one-half inches long, none less than four and one-half, the widths ranged from one and one-half to one and three-quarters inches The blades were remarkably uniform in shape About half were black chert, and all except three of the remainder were dark gray chert, the three exceptions being impure quartz of an unusual variety (not chalcedony), which, when held to the light, was partly translucent, much like smoky quartz Were I asked to classify these artifacts, I should call them cutting blades or knives They were well chipped, and the unusual black chert from which half or more were made would lead one to believe that they were worked from a stray boulder picked up in the glacial drift and perhaps originating far north, although I have seen somewhat similar material from Charity Island in Saginaw Bay Since I have not looked over these pieces in several years I cannot express a definite opinion, it is possible that the gray blades were from the same piece of rock I have named this the Armstrong cache, after the young man who found it With the exception of a few pieces it is now in the possession of Dr R M Kempton

Mr Henry Bornhoff has informed me of a cache plowed up about 1890 on his father's farm in Saginaw County, near where the Pere Marquette Railroad crosses the line between Sections 33 and 34 in Thomas Township It was found about three hundred feet south of the railroad track, near the road, which at that time followed the old Indian trail along the sand ridge westward, but which has since been straightened A great sand hill close to the spot has been entirely removed This hill was a landmark and was undoubtedly known as such by the aborigines The artifacts were found packed together in a small space about a foot beneath the surface, and Mr Bornhoff recalls that he and a brother gathered them up, filling a four-quart measure. There were about fifty or sixty leaf-shaped blades from two to six inches long, made of the common Bayport chert Since they were not notched the boys did not consider them of any interest as relics, and used them for "slingstones," as Mr. Bornhoff called them, for the lads each had a two-string sling. Rounded pebbles

were scarce, so they used chert flakes, defective or broken arrow points, or whatever came to their hands in the shape of a stone As a consequence, the contents of the cache were scattered in all directions by the boys in their play I have called this the Bornhoff cache

Mr Stroebel[8] has described a remarkable cache found by him on a sand knoll on the Fraser Village site, 272 feet westerly from Mr Charles Watson's farmhouse It numbered forty-six blades and pieces of the familiar Bayport chert A few of the smaller flakes were not worked, but most of the group had been roughly chipped; they had apparently been stored away for future working Their size indicates that they were struck off from a very large nodule or nodules, the lot weighing thirty-four and one-half pounds, the largest, two pounds and ten ounces The pieces were laid compactly together in a space sixteen inches in diameter and eight inches deep, the top piece being seven inches below the surface It is probable, since plowing and the winds have removed much of the loose sand from the knoll, that they were originally buried about two feet deep This has been named the Watson cache Mr Watson has told me that he had previously plowed up two lots of small flakes or blades, but as they were not worked to any specialized form he did not pay much attention to them, and they were scattered by the plow From his casual description I judged they were plain leaf-shaped blanks stored for future working I learned that these two lots were in the vicinity of the Watson cache just described, a short distance northeast I have called them Watson caches 2 and 3

In November, 1916, while collecting on land owned by Mr George Stroebel, in James Township, Saginaw County, on the Stroebel Village site, I noticed on a sand knoll southwest of the farmhouse four leaf-shaped blades lying close together. I had long suspected a scattered cache at this particular place, for I had found, at various times, sixteen similar blades within a space five or six feet in diameter, all of them peculiarly tinged with ocher-yellow spots and streaks, as were the four new ones I procured a shovel and gathered seven more pieces, making a total, to that date, of twenty-seven My field notes read: "They average about three inches long and one and one-half inches wide. They appear to have been cached near the surface, for they have been scattered by the plow, I presume others

[8] Stroebel, Ralph, "A Cache of Chert Blades in Saginaw County, Michigan," *American Antiquity*, 3 (2): 186–187 1937

will be found the coming spring" Others were found, until those collected by me numbered fifty-eight, in addition, Mr Ralph Stroebel collected several more Years later, some distance from this spot, I found on a sand knoll which had been swept bare by high winds a pile of flakes and chips, together with a hammerstone that had evidently been used to strike off the flakes from nodules This waste material was of the same chert from which the cache blades had been made, the yellow stains, texture, and lines of formation being identical My fifty-eight blades, together with the flakes and hammerstone, are now in the possession of Mr Walter Hastings of Howell, Michigan From the form of these blades, they were undoubtedly intended for later specialization as arrow points or other small artifacts, such as scrapers

Another cache, if such it can be called, was collected by me west of the Green Point mounds, within the corporate limits of the city of Saginaw, after a spring flood which bared many relics It consisted of seven pieces of a symmetrically round six-inch chert nodule, and comprised two thirds of the whole sphere The pieces had been laid together, some of them showed the bulb of percussion, indicating the spot on the nodule where the hammerstone had struck This nodule was of fine quality chert I presume it had been buried to be used at a future time

Several years ago a cache consisting of ten rude leaf-shaped blades about three inches long, four rough triangular points, six crude cutting blades, two well-formed but roughly chipped straight-base leaf-shaped blades, one fair cutting blade of irregular form, two chipped flakes, and a single fragment — all of dull black chert — was found "near the bridge in Bridgeport," close to the site of the Andross mound, since entirely removed This collection, now owned by Dr R M Kempton, cannot be classed as unfinished blanks or as a votive offering save by a considerable stretch of the imagination The pieces would seem to me to have been the product of an amateur workman, or of a boy making a first essay at flint-working, although the color of the stone, not found in this part of Michigan in any but very rare migrant specimens, might give rise to the conjecture that possibly this unusual attribute was a contributing factor to their deposit from religious or similar motives

About twenty-five years ago, Mr William B Mershon, of Saginaw, wrote me that in his boyhood he found a cache of leaf-shaped

blades on the site of the Mershon Club House, near the present Pere Marquette Railroad tracks and north of the Saginaw city limits in Carrollton They numbered 130 blades, each about two and one-half inches long, and were apparently blanks to be finished into arrow points They were later scattered and lost, and Mr Mershon could not locate any of them at the time of writing

In 1914 Mr Amos D Lincoln told me that while plowing on his farm in James Township, on Section 8, eighty rods west of where the corners of Sections 4, 5, 8, and 9 meet, his plow struck what proved to be a store of chert blades This find was made near a large pine stump on a little rise of ground An old Indian trail formerly ran past this place down to a spot on the Shiawassee River now called Carr's Landing, it was the only place for miles up and down that stream where, in the "Great Marsh" of nearly a hundred square miles, the woods came down to the water, hence it was also an Indian landing place Mr Lincoln and his son carefully gathered up the blades, filling a ten-quart pail Later, many were given away and others were lost, so that on my visit to Mr Lincoln in 1914, only one could be found, which is still in my possession This Mr Lincoln stated to be typical of nearly the whole lot, although a few were notched at the base to form arrow points The one I have is three inches long by one and one-half inches wide, it is of the ordinary leaf shape, and the material is the common gray chert I presume that here again we have, in part, a store of blanks, although it is well to remember that a leaf-shaped blade may be an unfinished arrow or spear point, a cutting blade, a scraper, or a reject It *might* be, if of unusual material and beauty, a keepsake or even a charm When talking with Mr Lincoln so long ago I was somewhat less well informed concerning matters archeological than I am at present, and my thought then was that the slightly notched forms of which he spoke might have been totemic, but Mr Lincoln has told me within the last two months that they were just plain notched arrow points I have named this deposit the Lincoln cache

Many years ago, I was told of a find of a large number of arrow points at the time that the electric railway was built from Saginaw to Frankenmuth They were discovered by workmen making a cut through a rise of ground east of Frankenmuth Junction, but my informant could neither locate the exact spot nor describe the find except to say that there was a peck or more of "flint arrowheads"

To the layman "arrowhead" is a rather casual term, indicating almost anything from a chert chip to a spear point a foot long It seems that the cache was divided among some of the men who found it or who were present when it was uncovered As I remember, my informant was Mr Eugene Ellis, a thoroughly reliable person (since deceased), but his information came to him rather indefinitely, so that we can only give this cache a name I have therefore called it the Cook cache, after the man presumed to have been owner of the land contiguous to the railway

It is quite probable that other caches have been found in this region but have not been reported, and it is not improbable that other deposits will be brought to light by the farmer's plow or the archeologist's spade, or casually discovered otherwise, for the present Saginaw County was perhaps the greatest center of Indian population in the state, where converging streams formed natural highways and where great trails came to a common center — a crossroads, indeed, the Chippewa designation for the tract of land now called the city of Saginaw was *Kah-bay-shay-way-ning*, "the gathering place" Here the annual Corn Feast was held and councils decided momentous questions of tribal policy or government. Here generations lived and died, leaving their remains for our study and investigation

SAGINAW, MICHIGAN

LINGUALIZATION IN AUSTRONESIAN LANGUAGES· AN UNUSUAL CONSONANTAL SHIFT

FLETCHER GARDNER

GENERAL CONSIDERATIONS

THE Island of Mindoro, anciently called Mait and still so called by the inhabitants of its interior, lies near the center of the Philippine Archipelago For perhaps a century before the Spanish conquest piratical bands from Mindanao, Jolo, and Borneo occupied stations at Pinamalayan on the east coast and Mamburao on the west coast, from which they raided to Luzon and other islands At the urgent request of the inhabitants of Panay Juan de Salcedo, on his way to assist in the conquest of Manila in 1570, attacked the pirates at Mamburao and Paluan

The effect of the Moro occupation of the coasts of Mindoro was to drive the indigenous inhabitants into the mountainous interior, and this pressure continued until well into the nineteenth century In fact, the last raid took place in 1868 The isolation thus brought about has led to the preservation of some of the ancient arts and customs long extinct elsewhere The most important of these is the art of writing the ancient syllabary, which is closely akin to those of the preconquest Tagalogs, Bisayans, and others which at present survive in a decadent state among the Tagbanuas of Palawan

Anthropologically, Beyer (1) and Kroeber (4) classify the southern Mangyans as Indonesian or Proto-Malay Maliwanag (3), who has lived as a neighbor to them for almost half a century, says that there are at least ten thousand of them. They speak four dialects quite similar in vocabulary, but different in pronunciation The present preliminary paper, which was begun early in 1938, is the outgrowth of a study of the written and spoken languages of these people

For the benefit of those who are unfamiliar with Indic linguistic conventions they may be noted here. Agglutinative inflection is the

first and most important characteristic and is similar to that of the North American Indians Reduplication of inflective syllables, roots, or entire inflected words is a part of this system The second law is the RGHY series, also known as Van der Tuuk's first law, which is explained by Conant (2) According to this law, the Indonesian parent speech possessed a certain consonantal sound which, having been lost in some languages, as in Old Javanese, became *r* in Toba, Karo, Cam, and Malay, *g* in Tagalog, Bisaya, Formosan, Ponosakan, Chamorro, *h* in Dayak, Sangir, and Bulu, and *y* in Lampong, Gayo, and Pampanga He furnishes a set of tables dealing with the subject in great detail Thus the original Indonesian word *'iγat*, 'root, vein,' becomes in Toba *urat*, in old Formosan, *ugat*, in Dayak, *uhat*, in Lampong, *oya*, and is lost in the Old Javanese *uwad* This change is always interdialectal The examples given above are mesial, but the same principle holds good for both initial and final positions

The third law is generally called RLD, and it ordinarily governs inflective changes, but may also operate between dialects By an interdialectal principle *langit*, 'sky,' which is the commonest form, becomes *dangit* in Inibaloy and *rangit* in Zambali Bolinaw By inflection such changes as the Tagalog *dito*, 'here,' and *parito*, 'come here,' are very common It should be remembered that the ancient Philippine alphabets contain no separate letters for *r* and that in Mangyan and Tagbanua, the only surviving alphabets, the same character is used for both sounds

The fourth law is that of nasal substitution or prenasalization In this change the letters *b* and *p* become *m*, *g* and *k* become *ng*, and *s* and *t* change to *n* These changes are purely inflective and have been well set forth by Cecilio Lopez (5–6)

EXAMPLES OF LINGUALIZATION

The present paper deals with the formation of substantives and quasi-verbs by a principle apparently not hitherto reported, it is here called "lingualization" because of the occasional inflective replacement of all consonants, except *m* and *y*, by the letter *r* It is probable that *m* and *y* may also be included after further search If the word base begins with a consonant, the first syllable is reduplicated, and the initial of the word base is changed to *r* (see Class A) If the word base begins with a vowel, the change follows the initial vowel (see Class B) There is a single mutation into *l*.

The word given in Class C is borrowed from two Bisayan dialects The following examples will serve to clear the picture

CLASS A

b *mairibgon*, 'darling,' < *ibog*, 'love'
g *garamason*, 'clearing,' < *gamas*, 'cut weeds'
nagirinan, 'return,' < *ginan*, 'return'
h *harablan*, 'loom,' < *habol*, 'weave'
harampangan, 'conversation,' < *hampang*, 'speak'
nagharampang-an, < *hampang*
nagharampang-hampang, < *hampang*
hirigyaan, 'bed,' < *higya*, 'lie down'
hurugtanan, 'marriage ceremony,' < *hugot*, 'tie'
k *karanan*, 'eatable,' < *kanon*, 'food'
pagkaranan, 'dining place,' < *kanon*
karanon-on, 'much food,' < *kanon*
l *paaralaman*, 'farewell,' < *paalam*, 'goodbye'
nga *ngarangal*, 'talk nonsense,' < *nganga*, 'chew betel'
p *parakawan*, 'glutton,' < *kawon*, 'eat'
paraaway, 'quarrelsome,' < *away*, 'fight, quarrel'
parahampang, 'so saying,' < *hampang*, 'speak'
paradarhan, 'ask,' < *dara*, 'bring'
parapulokan, 'cockfighting,' < *pulok*, 'cockfight'
paradayek, 'one who climbs much,' < *dayek*, 'climb'
parainganan, 'governor, judge,' < *ingat*, 'guard'
paraturog, 'sleepyhead,' < *turog*, 'sleep'
s *saraputan*, 'wrapped bundle,' < *saput*, 'wrap'
suruguun, 'messenger,' < *sugo*, 'send'
t *taranuman*, 'planting,' < *tanum*, 'planting'
tarayakan, 'divorce,' < *tayak*, 'separation'
manarayakan, < *tayak*
tirindugan, 'erectness,' < *tindug*, 'erect'
magtiripnan, 'assembly,' < *tipon*, 'unite'

CLASS B

ad *aradalan*, 'learning,' < *adal*, 'learn'
ag *aragawan*, 'quarreling,' < *agaw*, 'quarrel'
an *aranakan*, 'womb,' < *anak*, 'child'
as *arasinan*, 'salt bed,' < *asin*, 'salt'
at *nagaratubang*, 'stared face to face,' < *atubang*, 'face to face'
aw *arawayan*, 'quarreling,' < *away*, 'quarrel'
is *irisgan*, 'lawsuit,' < *isig*, 'challenge'

CLASS C.

balayanan, 'sorcerer,' < Hiligayna, Sebuan *babaylan*, 'priest'

Apparently every consonant, except *m* and *y*, may change to *r* and *b* into both *r* and *l*. It is a part of the genius of all the Austronesian languages to find certain sounds euphonious and others distasteful. There is a widespread use of ligatures to avoid harsh

combinations of sounds Apparently, to the ear of the Mangyan a reduplicated consonant is unpleasant and is avoided by the change of one or the other of the consonants into *r* or, in case of the single word *balayanan*, into *l* It is believed that no similar mutation has previously been observed

San Antonio, Texas

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THE PROBLEM OF DIFFUSION AND PARALLEL EVOLUTION WITH SPECIAL REFERENCE TO AMERICAN INDIANS

PAUL HONIGSHEIM

THE history of the American Indian forms one of the most important branches of historical inquiry and philosophy. Although the Indians have common ancestors with other groups they lived in almost complete isolation for several thousand years. This situation provides the scientific investigator with an unusual opportunity to consider the following problems. What do all humans have in common, and in what sense and to what extent do influences, parallel development, and unique evolution by human groups separated from one another exist?

Europeans since the middle of the eighteenth century and, more recently, North and South Americans have thought of the history of the Indians and especially the growth of the more complicated of their cultures as highly independent of and parallel to the history of the Old World. This idea was a part of prevailing evolutionary theory. But since the end of the nineteenth century there has appeared an anthropological concept of a more romantic, metaphysical, pessimistic, and antievolutionary character.[1] It was first advanced

[1] The history of these theories is developed in the following publications by the author of this paper: "Die geistesgeschichtliche Stellung der Anthropologie, Ethnologie, Urgeschichte und ihrer Hauptrichtungen," *Festschrift, Publication d'hommage offerte au P. W. Schmidt* (hereafter cited as *Festschrift*), (Wien: Mechitaristen-Congregations-Buchdruckerei, 1928), pp. 844–864; "Adolf Bastian und die Entwickelung der ethnologischen Soziologie," *Kölner Vierteljahrshefte für Soziologie*, 6 (1) (München, 1926): 61–76; "Soziologische Fragestellungen in der gegenwärtigen prähistorischen und ethnologischen Literatur," *ibid.*, 7 (3) (1928): 331–343, and 7 (4) (1929): 427–446; "Ein Wort zu Adolf Bastians 100. Geburtstag," *IPEK (Jahrbuch für prähistorische und ethnographische Kunst)*, 2 (München, 1927): 82–91; "Eduard Hahn und seine Stellung in der Geschichte der Ethnologie und Soziologie," *Anthropos*, 24 (St. Gabriel-Mödling bei Wien, 1929): 587–612.

in Germany by Ratzel[2] and Frobenius,[3] and was further developed by Ankermann[4] and Gräbner[5] Later it was presented in a more extreme form by Father Schmidt,[6] Menghin,[7] and their schools, and was accepted by anthropologists of many countries, but not to any great extent by the French[8] Because it was supported in good part by monks and missionaries, it was for several years considered a specifically Catholic concept, but now it has opponents as well as adherents among Catholics[9] and among other religious and political groups

This paper will deal with these authors and their followers and with those of their opponents who hold the theory of parallel development Both sides maintain the historical approach and the conviction that American Indians came from Asia Therefore we may eliminate considerations of Indian autochthony,[10] of Atlantic im-

[2] Ratzel, F, *Die afrikanischen Bogen* (Leipzig, 1891)

[3] Frobenius, L, *Ursprung der Kultur*, Vol I (Berlin, 1898)

[4] Ankermann, B, "Kulturkreise in Afrika," *Zeitschrift für Ethnologie* (Berlin), Vol 37 (1908), *idem*, "Verbreitung und Formen des Totemismus in Afrika," *ibid*, Vol 47 (1915)

[5] The methodology of F Gräbner was first developed in his book *Die Methode der Ethnologie* (Heidelberg Carl Winter's Universitätsbuchhandlung, 1911) He gave the first application of his general theory in "Die melanesische Bogenkultur und ihre Verwandten," *Anthropos*, 4 (Wien, 1908) 726-780, 998-1032 The complete system of Gräbner is developed in the chapter "Ethnologie" in the volume *Anthropologie* of the series *Die Kultur der Gegenwart, ihre Entwickelung und ihre Ziele*, Section III, subsection v (Leipzig und Berlin B G Teubner, 1923), pp 435-581

[6] The chief anthropological work of Father Schmidt is one in collaboration with W Koppers, *Gesellschaft und Wirtschaft der Völker, Der Mensch aller Zeiten*, Vol III (Regensburg Josef Habbel, 1924) In subsequent footnotes this work will be cited as "Schmidt-Koppers" Many characteristic publications of writers who completely or partly follow Father Schmidt are published in *Festschrift*

[7] The main work of O Menghin is *Weltgeschichte der Steinzeit* (Wien Anton Schroll und Co, 1931) This work will hereafter be cited as "Menghin"

[8] The most representative publication of the French anthropologists who consider these phenomena mainly from the point of view of parallel development is the collection *Travaux et mémoires de l'Institut d'Ethnologie* (Paris, 1926-33) See the criticism by the author of the present paper "Altamerikanische Kulturen, primitive Kunst und Naturvölker im französischen soziologischen Schrifttum," *Kölner Vierteljahrshefte für Soziologie*, 12 (1) (München, 1933). 70-82, in which he tries to show why the theory of diffusion was not widely accepted in France

[9] Schmidt, "Ein Versuch zur Rettung des Evolutionismus," *Internationales Archiv für Ethnographie*, 29 (Leiden, 1928) 101

[10] This theory, which is strongly supported by many Latin-American anthropologists, has been definitely refuted by Aleš Hrdlička in his article "The

migration or influences,[11] of migration from Australia via a continent that has since disappeared,[12] and of Australian, Tasmanian, and Melanesian influence [13]

The basic essentials of the general theories developed by the diffusionist school of Schmidt and Menghin (their applications either to special kinds of cultures or to American Indians being disregarded for the time) can be summarized as follows The most important inventions during the prehistoric period were made only once, in Asia, not in isolation but as a part of a special cultural totality covering most spheres of human life Such a cultural totality can be recognized by the fact that many cultural traits, which in the sociological and psychological senses are not necessarily connected, regularly appear in close connection in the lives of every one of the corresponding groups For each of the less complicated cultures there is a corresponding one of greater complexity, which originated in and evolved from the simpler culture This process also took place in Asia There, too, a number of the original or more complicated cultures intermingled In some instances of such mixture one of the original cultures became predominant in the new compound culture Every one of these cultural entities, both the simple and the compound, spread by migration and by diffusion from Asia to other continents, where some of them still exist and where the same process of intermixture occurred [14]

In the older system of Father Schmidt there are, including the mixed cultures, nine such cultural entities; in the more highly de-

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Origin and the Antiquity of the American Indian," *Ann Rep Board of Regents of the Smithsonian Institution* (Washington, 1923), pp 486–487

[11] See Posnansky, A , "Precursores de Colon," *Publicaciones de la Sociedad de Historia Argentina*, 1 (Buenos Aires, 1933) 1–14

[12] This theory was refuted by Hrdlička in his article "Melanesians and Australians and the Peopling of America," *Smithsonian Misc Coll* , 94 (2) (Washington, 1936) 19–27

[13] Such theories were especially emphasised by J Imbelloni in his articles "Fuéguides et Laguides," *Zeitschrift für Rassenkunde*, 5 (Stuttgart, 1937) 310–314, "Tabla clasificatoria de los Indios," *Physis*, 12 (Buenos Aires, 1938) 240–247, "El Poblamiento primitivo de America," *Cursos y Conferencias*, 12 (Buenos Aires, 1938) 22–23. The opposite point of view is emphasised by Hrdlička, *op cit* in note 12, pp 11–42, and by F. Boas, "Relationship between North West America and North East Asia," in *The American Aborigines, Their Origin and Antiquity*, ed Diamond Jenness (Toronto. The University of Toronto Press, 1933), pp 359–361

[14] Schmidt-Koppers, pp 67–75, 115, 298–299, 567–580; Menghin, pp 507–603

veloped system of Menghin there are fourteen, each of which represents a physico-anthropological group, a linguistic entity, and an Old World prehistoric style [15]

After an imperceptible original culture [16] came the oldest perceptible culture, that of the Pygmies, with the following characteristics predominance of wood implements, bows and arrows, monogamy, and monotheism [17] Out of this Pygmy culture branched three more complex cultures [18]

1 The so-called Eskimoid culture or, in terms of Old World prehistory, the pre-Mousterian, with ascendancy of bone implements This culture gave rise to the original Asiatic animal-husbandry civilization,[19] which produced the various groups of predominantly horse- or cattle-raising nomads, who later became the state founders in China, western Asia, and Egypt

2 The so-called Tasmanoid,[20] or pre-Chellean, culture, characterized by prevalence of stone implements, especially stone blades, and by the nonexistence of axes and bows and arrows This pattern

[15] Schmidt-Koppers, pp 75–79, Menghin, pp 479–594

[16] Menghin, p 570

[17] The monotheism theory was most fully developed by Schmidt in his work *Der Ursprung der Gottesidee*, zweite stark vermehrte Auflage (Münster i W Aschendorf, 1926 and subsequent years) See also the following special publications of adherents of Father Schmidt dealing with the theory of monotheism of Pygmies and Pygmoids Koppers, "La Famille chez les peuples primitifs," *Les Documents de la vie intellectuelle*, Dec , 1929—Jan , 1930 (Juvicy, Seine et Oise, France) 22–27, *idem*, "Die Eigentumsverhältnisse bei den Yamana auf Feuerland," *Estratto da Atti del XXII Congresso Internaz degli Americanisti* (Roma, 1928), pp 181–183, *idem*, "Individualforschung unter den Primitiven, im besondern unter den Yamana auf Feuerland," *Festschrift*, p 364, Schumacher, P R , "Gottesglaube und Weltanschauung der zentralafrikanischen Kivu-Pygmäen Bagesera-Basigaba," *Festschrift*, pp 678–681, Schulien, P M , "Opfer und Gebet bei den Atchwabo in Portugiesisch-Ostafrika," *Festschrift*, pp 671–676, Gahs, A , "Kopf-, Schädel- und Langknochenopfer bei Rentiervölkern," *Festschrift*, pp 241, 243, 248, 258, Gusinde, M , "Das höchste Wesen bei den Selknam auf Feuerland," *Festschrift*, pp 271–274, *idem*, "Die Eigentumsverhältnisse bei den Selknam auf Feuerland," *Zeitschrift für Ethnologie*, 58 (5–6) (Berlin, 1926) 406, *idem*, "Die Geheimen Männerfeiern der Feuerländer," *Akademieberichte "Leopoldina,"* 4 Amerikaband (Leipzig [n d]) . 356, 358, 364, 370

[18] The best surveys of these cultural entities are given by Menghin, pp 479–535, and, in a less complicated form, by Schmidt-Koppers, pp. 65–112

[19] Flor, F , "Zur Frage des Rentiernomadismus," *Mitteilungen der Anthropologischen Gesellschaft in Wien*, 60 (1930) 304, Gahs, *op cit.*, pp. 267–268

[20] Schmidt, "Die tasmanischen Worte zur Bezeichnung archäolithischer Werkzeuge," *Zeitschrift für Ethnologie*, 30 (6) (Berlin, 1910) · 918

spread from middle Asia to a number of countries, including Tasmania, where its representatives died out in the nineteenth century From it the Totemistic civilization, with such manifestations as plastic art and spear throwing, evolved It came by migration and diffusion to western Australia, New Caledonia, and some parts of Africa, in the European prehistoric epoch it was represented by the Magdalenian

3 The so-called Australoid culture, which developed in tropical British India It is characterized by fist wedge, boomerang, sticks used by women for gathering roots, and small, stick shields This culture spread to other countries, including southeastern Australia In Asia the original horticultural civilization, of which horticulture by means of the hoe, matrilinear society, men's secret associations, pottery, geometric ornaments, and masks are typical, evolved from it It spread to Melanesia and parts of Australia and was, in European prehistory, represented by the Solutrean period From the original horticultural kind of life there developed in southeastern Asia the more recent horticultural matrilinear society, with domesticated swine and lake dwellings for more than one family It spread to other parts of Asia and in Europe was represented by the Neolithic Campignian

This system and this classification were also applied to America,[21] and the following statements were made (1) The Pygmy culture is represented by some Fuegian tribes,[22] (2) The Eskimoid bone culture forms the background of all American Indian cultures,[23] (3) The Tasmanoid blade culture reached America in an interglacial epoch and is represented primarily by the Yamana, one of the Fuegian tribes,[24] (4) Totemism came to America combined with elements of the original horticultural civilization and was, in this form, one of the basic elements of the Inca Empire,[25] (5) The Aus-

[21] A survey of such application was given for the first time in Schmidt-Koppers, pp 115–127

[22] See the publications of Schmidt, Koppers, and Gusinde cited in footnote 17

[23] Menghin, p. 597

[24] Menghin, p 598

[25] Menghin, p 603, Schmidt-Koppers, pp 119–121, Trimborn, H, "Die Regelung der öffentlichen Gewalt im Inkareich," *Festschrift*, p 748, *idem*, "Die kulturgeschichtliche Stellung der Lamasucht," *Tagungsberichte der Deutschen Anthropologischen Gesellschaft* (Leipzig, 1928), p 43, *idem*, "Familien- und Erbrecht im präcolumbischen Peru," *Zeitschrift für vergleichende Rechtswissenschaft*, 42 (Stuttgart [n. d.]). 354, *idem*, "Straftat und Sühne in Altperu," *Zeitschrift für Ethnologie*, 57 (3–6) (1925). 204 *et passim*

traloid fist-wedge culture is represented by the more or less isolated central Californians living without Totemism and matrilinear family organization,[26] (6) The original horticultural civilization is represented by many prehistoric implements and historical cultures in northwestern and central North America and, together with Totemistic elements, is one of the basic cultures of the Inca Empire,[27] (7) The more recent horticultural matrilinear way of life is represented by the Iroquois and Pueblos in North America and by the Caribs and Arawaks in northern South America, near the Orinoco and Amazon,[28] (8) The animal-husbandry nomadic culture, with its large patriarchal family organization and warrior mentality, forms one of the basic elements of the more complicated civilizations of Central and South America, especially of the Inca Empire[29]

Before considering these applications of the system of the diffusionist school to American Indians we must first examine the system as a whole and its statements about the essential cultures

Certainly there occur in widely separated localities many almost identical combinations of cultural traits not of necessity sociologically or psychologically connected with one another In view of this fact, there probably exists in these places the same cultural entity going back to the same common center In that sense the dominant idea of the European diffusionists is an acceptable working hypothesis But there is insufficient evidence to permit us to regard such a concept as a theory and the supposed relation as a rule, especially when investigation reveals that the relation between the single phenomena is not as it has been described and that there are exceptions to the general rule that has been asserted Let us first consider a few salient facts which are not directly and necessarily connected with America

1 A homogeneous Pygmy culture, common to all Pygmy groups, has never existed Certainly the one element, monotheism,[30] which

[26] Schmidt, "Die Altstämme Nordamerikas," in *Festschrift Eduard Seler* (Stuttgart Strecker und Schröder, 1922), pp 471–502, Menghin, p 485

[27] Menghin, pp 497, 603, Schmidt–Koppers, p 121, Trimborn, *opera cit.*

[28] Menghin, pp 511, 605, Schmidt–Koppers, pp 121, 608.

[29] Schmidt–Koppers, pp 126, 598, 608, Koppers, "Das Problem der Entstehung der Tierzucht," *Vorträge des Vereins zur Verbreitung naturwissenschaftlicher Kentnisse in Wien*, 69 (Wien, 1929) 51

[30] Written especially against the monotheism theory of Father Schmidt is the pamphlet by J J Fahrenfort, *Wie der Urmonotheismus am Leben erhalten*

has been attributed to all these groups is not, in fact, universal among them

2 Even though such a Pygmy culture exists it cannot be considered the oldest known civilization All the Pygmies have bows and arrows, but these weapons appear regularly for the first time in the Neolithic epoch

3 The original animal-husbandry way of life cannot be related to the Eskimoid civilization The Eskimo did not domesticate the reindeer, although other peoples did, and the domestication of other animals, farther south, preceded that of the reindeer [31]

4 Domestication of animals, generally speaking, cannot be associated with these northern cultures because it is closely related to the Totemistic culture, as will be pointed out later

On the other hand, some of the complex cultures, which the diffusionists claim to be migrated ones with common origin, actually are such Without considering their connection with American Indians and with some restriction on the relations which it is asserted existed between them and European prehistoric styles, we can accept the following entities (1) the Paleolithic blade culture and its migration to Tasmania, (2) the fist-wedge culture and its migration to southeast Australia, (3) totemism as a culture whole and its migration to parts of Australia and Africa, (4) the original horticultural civilization and its migration to parts of Africa

In each of these a particular combination of traits, which sociologically and psychologically are not necessarily connected with one another, is found in widely separated localities But what about inclusion of Indians in the diffusion system?

Until recently it was generally accepted that the oldest remnants of prehistoric American culture could be traced back to the more recent sections of the upper Paleolithic epoch [32] New material has been found, however, which closely resembles the forms of the lower

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ward (Groningen, Haag Wolters, 1930) The author of the present paper does not agree on all points with the theories of Fahrenfort

[31] Lowie, R H, "Subsistence," *General Anthropology*, ed Franz Boas (Boston D C Heath and Co, 1938), pp 311–312

[32] Nelson, N C, "Prehistoric Archeology," *General Anthropology*, p 215, *idem*, "Antiquity of Man in America," *The American Aborigines, etc.*, pp 87–129, Hrdlička, "The Coming of Man from Asia in the Light of Recent Discoveries," *Ann Rep Board of Regents of the Smithsonian Institution* (Washington, 1936), pp 463–469, *idem*, *op. cit.* in note 10, p 490.

Paleolithic of Europe and seems to indicate that man may have been in America since the last stages of the Pleistocene.[33] But there is no evidence of any special relation between this oldest known American culture and the supposed Pygmy culture (the very existence of which now appears improbable) or the Tasmanoid blade culture.

We are justified in accepting, however, the migrations of at least two types of culture to America, for in two instances we find the same particular combination of traits in America and in the Old World. The first of these two cultures is Totemism, represented in North America by the Tlinkits and in Central and South America by many dispersed groups, and forming one of the basic elements of the Aztec, pre-Inca, and Inca civilizations. The second is the matrilinear horticultural type represented in America by Iroquois, Pueblos, Caribs, and Arawaks and forming one of the bases of the Maya culture and of some pre-Inca civilizations. Since Indians immigrated to the New World without seed and cultivated plants the following possibility exists. At the end of the upper Paleolithic epoch Mongoloids came to America. It is likely that they were similar in their behavior to the people of the fist-wedge culture, without seed and knowledge of planting but with some technique of root-gathering acquired by the women and with some predisposition to the development of horticulture. Under favorable circumstances they succeeded at this pursuit as did other people with the same background in tropic British India and elsewhere.

This much, but no more, can be accepted. Certainly migration, or even diffusion, of an animal-husbandry and state-founder civilization from Asia to Peru never occurred. No remnants of such a culture can be found at any point along the entire land route, and the Polynesian influence was only peripheric.[34] Moreover, the more

[33] Roberts, F. H. H., Jr., "A Folsom Complex," *Smithsonian Misc. Coll.*, 94 (4) (Washington, 1935) 1–35, Bryan, K., and Ray, L., "Geological Antiquity of the Lindenmeier Site in Colorado," *Smithsonian Misc. Coll.*, 99 (Washington, 1940) 69–72, Bryan, K., "Stone Cultures near Cerro Pedernal and Their Geological Antiquity," *Bull. Texas Archeol. and Paleontol. Soc.*, 2 (Abilene, Texas, 1939) 9–48, Cassell, R. K., "A Postulated Corridor of Folsom Migration," *Pap. Mich. Acad. Sci., Arts, and Letters*, 26 (Ann Arbor, 1941) 451–457.

[34] P. Rivet has overemphasised the influence of Polynesians on American Indian culture in his article: "Relations commerciales précolumbiennes entre l'Océanie et l'Amérique," *Festschrift*, pp. 583–603. That the Polynesians brought some special goods was shown in the following publications. Seler, E., "Über den Ursprung der mittelamerikanischen Kultur," *Gesammelte Abhandlungen*, 2 (Ber-

complex civilizations of Central and South America, especially the Andes civilization, indicate that sometimes, when the same factors are converging in two widely separated parts of the world, the same results appear To justify this statement, let us go back to Totemism

Totemism is a religio-social kind of life [33] The desire to have near the dwelling a powerful sacred animal can, under favorable circumstances, lead to the animal's semidependency within an enclosure and sometimes finally even to animal husbandry — primarily not an economic but a religious practice This process occurred under similar circumstances both in Asia and in the Andes, where in some places the existence of herds of domesticated animals developed the capacities for organization of the people and gave them forces which neighboring peoples did not have Thus the animal-husbandry people could subjugate the others, take over their land, force the subjected people to work for them, and found the state Among other proofs that this is true, there is an indirect one the development from Totemism to animal husbandry never took place in Central America because of the lack of qualified animals Therefore, instead of a centralized state organization as in the Andes, only confederations developed Because of the continuation of the patriarchal great family — corresponding to the Roman "gens" with their militaristic character and mentality — the confederation among the Aztecs was comparatively tightly knit Among the Mayas it was looser because

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lin, 1904) 16–18, Hornbostel, M v, "Die Massnorm als kulturgeschichtliches Forschungsmittel," *Festschrift*, pp 304–306, Imbelloni, "La Première Chaine isoglossomatique océano-américaine," *Festschrift*, pp 324–334, Nelson, "Prehistoric Archeology," as cited in note 32, pp 209–212, Dixon, R B, "Contacts with America across the Southern Pacific," *The American Aborigines, etc*, pp 315–353, Boas, "Relationship between North West America and North East Asia, etc," *The American Aborigines, etc*, pp 357–370, Wissler, C, *The American Indian*, 2d ed (New York Oxford University Press, 1922), p 390

[33] This concept of Totemism was developed — with some reference to Gräbner's chapter "Ethnologie," as cited in note 5, p 468 ff — by the author of the present paper in "Die Wanderung," *Verhandlungen des 6 Deutschen Soziologentages* (Tübingen Mohr, 1929) pp 138–139, 200–201, "Kulturkreislehre, prähistorisch-ethnologische Zusammenhänge und primitive Kunst," *IPEK*, 4 (München, 1929) 126–128, "Kulturkreistheorie und Evolutionismus," *Bericht über die 51 Tagung der Deutschen Anthropologischen Gesellschaft*, Sonderdruck aus der *Mainzer Zeitschrift*, 26 (Mainz, 1931) 69–70; "Viehzüchternomadismus, Bodenrente, Reichtumsbildung, Staatsgenesis," *Kölner Vierteljahrshefte für Soziologie*, 11 (München, 1932). 84 ff, "Altamerikanische Kulturen, primitive Kunst und Naturvölker im heutigen französischen soziologischen Schrifttum," *ibid*, 12 (1) (1933) 75

they did not have such a background and because the matrilinear-horticultural elements became more dominant in the mixture of cultural forms

Additional examples could be given They would supply further evidence that, although both bases of historical investigation of early cultures provide useful working hypotheses, they lead to unacceptable exaggerations when taken as generalizing theories The truth lies not in the setting up of an opposition between diffusionism and the theory of independent parallel development but in the higher synthesis of the two

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NOTES ON THE MANUFACTURE OF RUSH MATS AMONG THE CHIPPEWA

VERNON KINIETZ AND VOLNEY H JONES

THROUGHOUT most of aboriginal eastern North America mats were a rather common article of manufacture and use among the Indians Many references to ones of bark and rushes or "reeds" can be found in the early historical literature Such mats are seldom made today, for they have been almost entirely supplanted by commercially manufactured products, and few of the Indian women are familiar with the procedures involved Since the making of rush mats appears not to have been previously described with any great degree of completeness it seems worth while to record our notes on this interesting process as it occurs among the Chippewa of the Great Lakes region

Mr Jones observed the gathering and preparation of materials and the early stages of manufacture at the Walpole Island Reserve in Ontario in 1933 [1] Mr Kinietz witnessed work in progress on mats by two Indian women at Lac Vieux Desert, Michigan, in 1939 and 1940,[2] and took notes on various steps and procedures It should be pointed out that neither of us watched the entire process of mat manufacture from beginning to end, but we believe that our composite notes offer a basis for a fairly complete description

The essential materials used in making rush mats are two - - stems of the common bulrush (*Scirpus validus* Vahl) for the warp strands and inner bark of the basswood tree (*Tilia americana* L) for the manufacture of cord for the border and weft Detailed descriptions of the preparation of basswood fiber and its manufacture into cord have been given by Jones (5) and need not be repeated here Such cord is an article of commerce in some Chippewa

[1] Mr Jones was engaged at the time in field work as the Homeopathic Hospital Guild Scholar in Michigan Ethnology, University of Michigan

[2] Mr Kinietz' observations were made in the course of field work supported by a grant from the Horace H Rackham School of Graduate Studies, University of Michigan

villages, a ball about eight inches in diameter sells for seventy-five cents at Lac Vieux Desert These same materials seem to have been employed in rush-mat manufacture throughout most of the Great Lakes region Smith reports that *Scirpus validus* was the plant used for the warp by the Menomini (7, p 74), Meskwaki (9, p 268), Ojibwe or Chippewa (10, p 418), and Forest Potawatomi (11, p 112) of Wisconsin, and Densmore concurs for the Chippewa of Minnesota (2, p 154) Other authors, such as Boyle, Hilger, Hoffman, and Skinner, say simply that "rushes," "bulrushes," or "reeds" were the material utilized, and give no further identification Most of these authors agree that basswood cord was the weft material The only notable exceptions are that, according to Smith, the Ojibwe (Chippewa) of Wisconsin (10, p 418) used cord of nettle fibers and the Meskwaki (9, p 268) employed this material as well as basswood At present, commercially manufactured cord is often used Through a part of one mat from Beaver Island, Michigan,[3] alternate pairs of weft strands are of basswood cord and cotton fishline

The rushes, which occur in shallow water along lakes and streams, are usually gathered in midsummer, when they approach their maximum growth At Walpole Island they were collected in early August Skinner (6, p 239) says that they are "ripe" in June and July The women wade into the water to get the stems, selecting mature plants of medium size Smith, in his accounts for the Meskwaki (9, p 268), Ojibwe (10, p 418), and Forest Potawatomi (11, p 113), stresses the importance of choosing long rushes of small diameter and small pith area and asserts that the firmness and resistance to wear of such rushes are recognized as desirable qualities by the Indians Those gathered at Walpole Island were from one-quarter to one-half inch in diameter at the base and from five and one-half to six and one-half feet long Plate I, Figure 1, shows Mrs Smith selecting rushes

Each rush is grasped near its base with both hands and pulled steadily until it separates from the rootstock Care is necessary in pulling, since jerking may crush or break the rush The sheath enclosing the base of the stem is stripped off, after which the base is washed by swishing it through the water The accounts of Skinner

[3] University of Michigan, Museum of Anthropology, No 13632 Collected in 1932 by Mr Walter Hastings on High Island, of the Beaver Island group, Michigan

(6, p 239) and Hilger (3) concerning the gathering of rushes agree closely with our notes Hoffman (4, p 259), referring to the Menomini, says that the rushes are "cut," but he must be mistaken in this, for the general practice seems to be to pull the rushes Hilger (3), Skinner (6, p 239), and Smith (9, p 268, 10, p 418) substantiate this opinion

About three hours are required to collect sufficient rushes for an average mat When tied, for transportation to the house, these form a bundle about a foot in diameter After arrival there the rushes are sorted, trimmed, "killed," and cured before they are ready to be woven into the mat These processes require several days

Any broken or otherwise unsuitable rushes are culled from the supply The smaller flowering ends are trimmed, which reduces the length by about six inches Care is taken to make the rushes all about the same length They are then killed by a hot-water treatment Mrs Smith accomplished this by standing the bundle in a wash boiler and pouring scalding water over the rushes several times (Pl I, Fig 2) Skinner's description of the Menomini process (6, pp 239–240) agrees closely, but he states that the rushes were supported by a board during the scalding Mrs Smith says that formerly it was customary to immerse the rushes in boiling water in a hewn wooden trough Hilger (3) describes the Red Lake Chippewa as tying the rushes in bunches and boiling them, and Hoffman (4, p 259) remarks that the Menomini steeped the rushes in boiling water, but neither author mentions the type of receptacle used

The killing process is important in fixing the texture of the rushes and in removing the green coloring matter Rushes allowed to dry without such treatment are said to be brittle, less firm, and to have a less desirable color After killing, the rushes are spread to dry and bleach in the sunlight They are generally strewn on the grass, but Densmore (2, p 154) describes drying racks used by the Minnesota Chippewa Hilger (3) reports that the rushes were turned several times a day to ensure uniform drying and were taken in at night to prevent yellowing by dew, but neither of these was done at Walpole Island Smith ascribes a quite different curing process to the Wisconsin Ojibwe (10, p 418) and Forest Potawatomi (11, pp 112–113) The rushes are said to be immersed in water in a lake until they become white. We have not heard of this method elsewhere and do not believe that it was practiced widely

About a week is required for bleaching and drying, at the end of which time the rushes should have acquired a uniform color and should be well seasoned and ready for use or storage Sources do not agree as to the effects of the killing and curing processes Hilger (3) says only that the rushes were boiled until the green color disappeared, and were then bleached in the sun Skinner (6, p 239) notes merely that the rushes "change color" Smith describes the bleached rushes variously as "ivory white" (9, p 268), as "pure white" (10, p 418), and simply as "white" (11, p 113) The undyed rushes which we have seen in some completed mats are all more or less tan Those prepared at Walpole Island appear to have been poorly cured, for they retain considerable green

The rushes may all be left tan, or some may be dyed to furnish additional color and design to the mat Dyeing is usually done before the rushes are stored or before any of the weaving is begun This requires that the pattern of the prospective mat be visualized and planned ahead Skinner (6, p 240) says that the Menomini calculated the number of rushes of each color needed and sorted and counted them in advance The undyed rushes and the various lots of dyed rushes are tied in separate bundles (9, p. 268), and are then ready for weaving into the mat

Our data and those from other sources agree that formerly the rushes were dyed with native dyes, but that in more recent times commercial aniline ones have been used almost exclusively. Although some of the older mats examined seem to have been colored with native dyes it is difficult to determine definitely their nature Little information on this is available in most communities Smith says that he could learn nothing about native mat dyes from the Ojibwe of Wisconsin (10, p 418), and gives nothing concerning them for the other tribes which he studied Our informants at Walpole Island and Lac Vieux Desert had little knowledge of native dyes, but spoke of bloodroot (*Sanguinaria canadensis* L) as a source of red, the bark of black walnut (*Juglans nigra* L.) for brown, and a black earth, which we think may be peat, for a purplish black. Hilger (3) describes a "black-muck" dye, and Densmore (2, p. 163), a "black-earth" dye, which may be the same as Hilger's Other native dyes noted by Hilger (3) are a mahogany color from alder and red from bloodroot Densmore (2, p 163) lists an imposing number of native dyes used for various purposes by the Chippewa; she men-

tions that colors were used on mats (p 155) but does not give their sources Hoffman (4, p 259) refers to dull green, red, and brown, and Boyle (1, p 26) gives dark blue, red, and green, but neither states the origin of these colors Our observation is that purple, green, red, blue, yellow, and brown most commonly appear on rush mats

Mrs Smith of the Walpole Island Reserve had sufficient recollection of the use of walnut bark to demonstrate its preparation as a dye A quantity of bark was peeled from the tree and placed over a wood fire in a wash boiler about half full of water After the water began to boil and to assume a brown color, rushes were added Since the boiler could not accommodate the rushes to their full length, they were moistened to make them flexible, and twisted into coils After being boiled for about four hours, the rushes were allowed to stand in the dye vat overnight and removed the next morning, when they were rinsed in clear water, uncoiled and straightened, and placed in the sun to dry By this time they had acquired a deep, rich, brown color Skinner's account of the Monomini dyeing process (6, p 240) is essentially similar, but he does not specify the dye Hilger's description (3) differs in that after the dye had been boiled the fluid was strained before the rushes were added Densmore (2, p 163) says that the material to be dyed was boiled in the coloring matter, reboiled, and if a dark shade were desired, allowed to stand in the dye vat overnight She makes the interesting statement that rushes were the most difficult material to dye, several dippings being required to fix the color properly

Once the rushes are thus prepared they are ready for weaving, and may be used immediately or may be stored If put in some sheltered place, such as house or shed, they will keep almost indefinitely. Some mat weavers maintain a supply ahead for one or more mats; this may be drawn upon at their convenience

Only very simple equipment is required for weaving The primary essential is a horizontal support from which the rushes are suspended while the cord is intertwined through them This may be little more than a pole crosspiece supported by other poles for uprights, as shown in illustrations by Densmore (2, pl. 61a, near p. 156), Skinner (6, pl 58, facing p. 239), and Hoffman (4, pl 20, facing p 261), and in our text figure 1 [4] This simple type of frame

[4] Drawings for text figures 1–2 were made by Mr Carleton W Angell, of the University of Michigan, to whom we express our grateful appreciation.

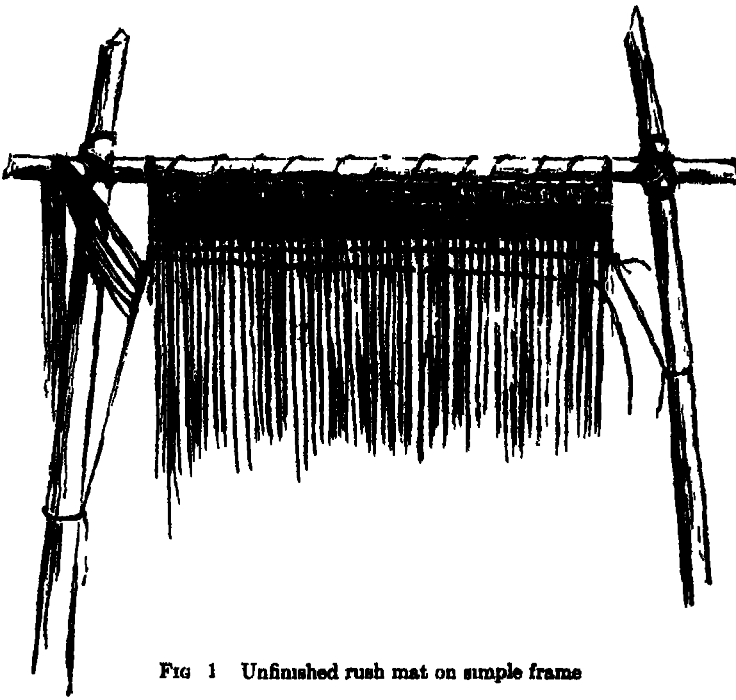

Fig 1 Unfinished rush mat on simple frame

was seen at Walpole Island A more elaborate frame may be constructed, as shown by Densmore (2, pl 1b, facing p xii) Another type, with an additional crosspiece that gives it certain advantages, which will be mentioned later, was employed at Lac Vieux Desert (Pl II, Fig 1) The frames are usually lashed together with strips of inner bark of basswood or with some other such bark The transverse pole is ordinarily at about the standing height of the weaver, or at least high enough so that the suspended rushes clear the ground by a few inches The length of the frame must of necessity be greater than that of the prospective mat Brief descriptions of mat-weaving frames are given by Boyle (1, p 26), Hoffman (4, p 259), Densmore (2, p 155), and Skinner (6, p 240) The frame is usually set up in some shady spot near the house, but may be in the house or under a shelter Shade is desirable not only for the comfort of the worker but also to prevent the moistened rushes from drying.

After the frame is ready the next step is the suspension of the rushes This is accomplished by binding one end of all the rushes together with basswood cord and then lashing this bound edge to the crosspiece of the frame The edge binding serves the double purpose of facilitating suspension and of later forming one of the borders of the mat

The binding of the ends of the rushes is a rather complicated technique, which has not previously been adequately described The account of Densmore (2, p 155) and her illustration of the border detail (2, pl 60a, near p 156) are not very informative The procedure as we have observed it is as follows A piece of cord more

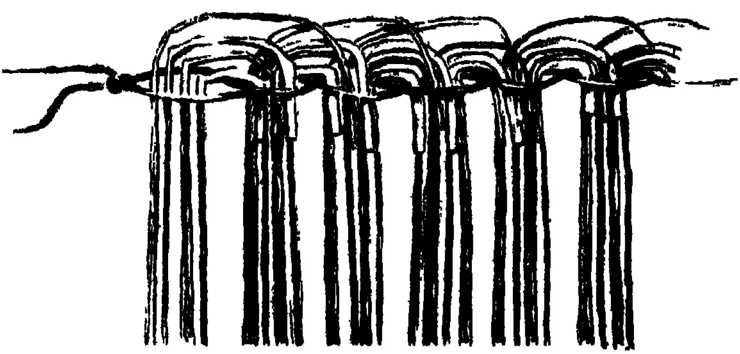

FIG 2 Detail of border of rush mat

than twice the circumference of the prospective mat — usually thirty or more feet long — is doubled and knotted in the middle The knot becomes the upper left-hand corner of the mat Starting from it and going from left to right, the worker fastens the rushes to the doubled cord in groups of four, as shown in text figure 2 The woman sits on the ground or on some low support with a supply of rushes spread out before her She picks up four and holds them against the knot between the two cords, with about four inches of the rushes extending through the cords toward her The rushes are held with the left hand, while with the right hand the two strands of cord are twisted to keep them in place The thumb of the left hand is then placed over the twist to hold it Four more rushes are now selected and their ends placed between the cords as before

Three of the projecting ends of the first group are bent over into the second group, with two of the second group above them and two below, thus concealing the ends The cords are twisted as before to hold the rushes in place A third group of four is then selected, placed between the cords as before, and into these are bent the remaining end from group one and three ends from the second group — all of which are tucked in as described above This process is repeated for the length of the mat, each bundle of four rushes receiving three ends from the group immediately preceding, and one from the second antecedent group When the desired length is reached, the last projecting ends are turned down and tied by knotting the two cords The details of the procedure are shown in text figure 2 Illustrations of women at work on such borders appear in Densmore (2, pl 60b, near p 156) and in Smith (8, fig 18, p 37)

Several features of the technique of border construction need further discussion In the groups of four rushes which are bound in together, two small ends and two large ends are always combined This is essential so that the finished mat will be of equal length and thickness throughout In laying out the rushes for work, half are directed each way, so that the worker will not have to turn them as she picks them up As the ends are tucked in they are trimmed with a scissors, the cut being tapered so that the ends will not cause too prominent a bulge or ridge Any dyed rushes with which designs are to be formed must be included in their proper place in the border, for they cannot be added later They are laid out along with the undyed supply, and intervals between design areas are calculated Since the dry rushes are brittle, and must be bent in forming the border, they are moistened to make them pliable This may be accomplished by pouring water over them or by wrapping them in a moist blanket or quilt and leaving them there overnight Water may be poured on them at intervals, hot water hastens the process The worker generally does the border in a cool, shady place so that the rushes will not dry too rapidly A pail of water is usually kept at hand so that some may be sprinkled on the rushes from time to time The cord may also be dipped into the water to soften it, after which it is pulled tightly about the groups of rushes, holding them firmly. The resulting border is smooth, firm, and neat, with no projecting ends A variation can be achieved by changing the number of ends carried over into the succeeding groups For instance, in

some mats it has been noted that only two rushes, instead of three, have been carried over This makes little difference in the general appearance of the edge and is detected only on close examination The lacelike effect of the finished border is shown in Plate III, Figure 1

After the completion of the border it is lashed to the crosspiece of the weaving frame, where it is held firmly against the pole and bound tightly with strips of bark The border is stretched to its full length by bark strands or cords fastening its ends to the uprights The free ends of the double cord used in making the border are tied tightly to the uprights near their bases The cords become the end borders As has been said, the pendant rushes are the warp of the mat, and basswood cord is the weft [5] The pieces of weft cord are cut in lengths slightly over twice that of the mat and are doubled, the doubled cord is then passed around the left border cord and the ends are pulled through the loop This leaves two free ends of equal length All is now ready to begin the actual weaving process

The weaver stands facing the suspended rushes and works from left to right One of the weft cords is worked through the rushes, under one, over the next, the rushes being manipulated with the fingers to facilitate the passing of the cord When the weaving has proceeded to the right-hand edge, the weft cord is tied to the right-hand border cord The weaver moves back to the left-hand side, takes the second weft cord and repeats the process, in an alternate direction to that of the previous weft (going under the rushes gone over the first time, etc) A new pair of weft cords must now be fastened to the left border, as before, and carried through This is repeated until the desired width of the mat is reached

There are many aids and variations to the essential weaving process just described A number of weft strands are usually fastened to the left border in advance, so that the weaving will not have to stop each time for the attachment of new ones. These strands are thrown back out of the way over the frame, as shown in Plate II, Figure 1, and in text figure 1 The weft strands may be attached almost contiguously or may be as far apart as an inch, depending on the fineness of the twine and the closeness of weave desired As the weft cord is tied to the right border cord the loose end

[5] Hilger (3) says that the rushes are the woof and the basswood fibers are the warp, but we have seen no processes or finished mats of which this is true

is not cut off, but is left hanging The next weft cord is tied over this, successive wefts thus bind the loose ends of the previous ones This results in the right border of the mat being rather coarse and bulky, as can be seen in Plate II, Figure 2, and in Plate III, Figure 1 The right and left borders are kept straight by cords running at intervals from the edges of the mat to the uprights and maintaining an even tension on the mat Such cords may be seen in Plate II, Figures 1–2, in text figure 1, and particularly in Hoffman (4, pl 20, facing p 261)

During the weaving the rushes must be moistened frequently to retain their plasticity and pliability If the rushes are moist and a constant upward pull is exerted on the weft cords, a very closely woven mat results Water may be applied by pouring from a vessel, sprinkling with the hand, or blowing from the mouth This last practice was noted at Walpole Island and is also mentioned by Hilger (3) and by Skinner (6, p 241) In spite of such precautions some of the rushes become brittle, break, and must be spliced A reserve supply of all colors is maintained for such emergencies When the broken end of a rush is approached in the weaving, another rush of the same color is inserted, with no fastening other than that furnished by the crossing over it of the weft cords

As the weaving proceeds the work area becomes ever closer to the ground, making it increasingly inconvenient for the worker The frames seen at Lac Vieux Desert ingeniously relieve this difficulty by providing arrangements to lower the crosspiece down the back of the supports and by having another top crosspiece over which the mat may hang The work can thereby always be adjusted to a convenient height Figures 1–2 of Plate II illustrate this feature

The weaving stops three or four inches short of the ends of the rushes, which are left to form the border The mat is removed from the frame and held in the lap while this border is constructed It is made just as was the first one, by turning in and binding the ends of the rushes [6] The cords forming the left border should be long enough to bind this last edge, but if they are not, additional cords

[6] It is evident from examination of some of the mats in the collections of the Museum of Anthropology that the weavers became impatient in binding the last border, for, although in the initial border the rushes were bound in the customary groups of four, here they are bound in groups of six When this is done in disposing of the ends two rushes from each group are carried over with four from the succeeding group

can readily be tied onto them The binding progresses from what was the lower left-hand corner of the mat while on the frame, to the lower right-hand corner The ends of the last rushes are turned down along the right border and bound to it The mat is now finished

Other sources seem to offer little detail on the actual weaving process, but the descriptions of Densmore (2, p 155), Hoffman (4, p 259), and Skinner (6, pp 240–241), so far as they go, agree in general with our notes, showing only occasional discrepancies The technique seems, therefore, to be rather uniform, throughout the Great Lakes region at least Weaving in progress is shown by Skinner (6, pl 58, facing p 239), Densmore (2, pl 1b, facing p xii), and Hoffman (4, pl 20, facing p 261) Drawings of a partly finished mat and of a detail of the weave are presented by Boyle (1, p 25) An uncompleted mat from Walpole Island is in the collections of the Museum of Anthropology of the University of Michigan [7]

Ornamentation and design may be introduced into rush mats by coloring some of the rushes, by varying the technique of the weave, or by a combination of these two methods Dyed rushes may occur in plain stripes, with no variation in the weaving — a very common practice — and several colors may appear in a single mat, the colors being alternated in spaced bands Ordinarily only a relatively small percentage of the rushes in a mat are dyed Design by weave variation is achieved by crossing the rushes over each other between the weft strands, which gives a zigzag appearance, as shown in Plate III, Figure 1 By this device rushes may be inclined diagonally across the mat for some distance, with more or less abruptness Another method of modifying design is by twisting adjacent rushes about each other, so that a raised effect results The rushes may be manipulated in pairs or in groups of four Variations in weave are sometimes carried throughout the entire mat, but are usually confined to areas of dyed rushes The combination of color and weave variation may result in elaborate and intricate geometric patterns, as shown in Plate II, Figure 2, and Plate III, Figure 2, and in Skinner (6, pl 59, facing p 242), Hoffman (4, pl 21, facing p 262), Smith (8, fig 17, p 36), Boyle (1, fig 32, p 25), and Densmore (2, pl 1, facing p xii, and pl 63, near p 157) Elaborate designs which are not geometric seem to be executed less often, but Skinner (6, pp 241–242) mentions the weaving into mats of conventionalized depictions of supernatural

[7] No 13794. Collected by V H Jones in 1933

beings and also illustrates a mat with floral designs (pl 60, facing p 243) Densmore (2, p 156) speaks of a mat with a pattern of a vine with leaves

There is considerable variation in the length of rush mats, but much less in the width This is to be expected, for the width is limited by the length of the rushes, whereas there is no material or technical limitation on the length Six mats in the collections of the Museum of Anthropology range from 26 to 42 inches in width, the average width being 36½ inches The range in length is from 49 to 87 inches, with 69 the average Smith gives the selling price of mats among some of the Wisconsin tribes as from eight to thirty dollars each (7, p 74, 9, p 268, 10, p 418)

The weaving of mats seems always to have been, and still is, "woman's work" Usually the weavers are old women who cannot engage in more strenuous tasks, but younger women assist them in their spare time Two or three persons can work on a mat at once, but of course it is necessary for each to have the pattern in mind The women gather and process the materials, as well as do the actual weaving They may receive some help from the men in the construction of the frame

Rush mats were primarily floor coverings, but seem to have found other uses as well Hilger (3) says that they were laid on the ground to serve as tables, food being placed on them Hoffman (4, p 259) mentions them as seats in the medicine lodge According to Skinner (6, pp 238, 242), rush mats were coverings for floors and benches and wrappings for war bundles, and handsome mats were prized as decorative wall hangings An illustration in Waterman (12, pl 1, fig 1, facing p 486) shows an Ojibwe (Chippewa) wigwam with walls made of what is said to be bulrush mats They are more probably cattail mats, for these were commonly used in the construction of habitations

The weaving of textiles by suspending the warp with ends hanging free is generally referred to, appropriately, as "suspended warp weaving" Such weaving is purely a finger technique, since no implements are used The progress of the weave is always downward or "toward the weaver" In these and other ways suspended warp weaving is distinct in equipment and technique from true loom weaving, and had a distribution in aboriginal North America quite apart from that of the latter, as is shown by Wissler (13, fig. 17, p 56).

Rush mats seem to have been manufactured formerly throughout the eastern area of suspended warp weaving (see Wissler), that is, in the western Great Lakes area and in the region east of the Mississippi River and south of the Ohio The practice of making them appears to have been well developed among the Central Algonquian Indians in general, and particularly among the Chippewa, apparently being common to all the groups of the tribe Except for the adoption of commercial dyes there seems to have been no change in the method of manufacture during historic times At present mats are seldom made, and the technique of their manufacture will probably be lost before many years have passed It is hoped that this paper will assist in preserving knowledge of this interesting trait

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PLATES I–III

FIG. 1 Selecting rushes for mats, Walpole Island

FIG 2 Scalding the rushes

FIG 1 Rush mat in process of weaving, Lac Vieux Desert

FIG 2 Back view of mat shown in Figure 1

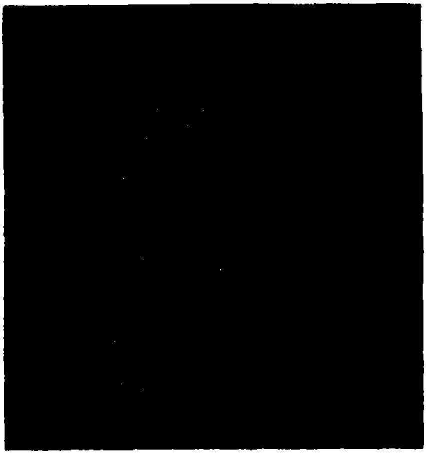

Fig 1 Detail of finished rush mat

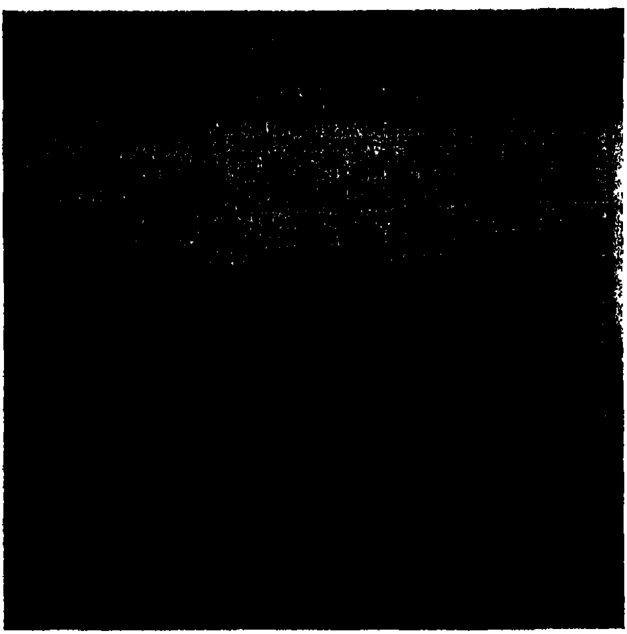

Fig 2 Lower part of a rush mat having a geometric design

THE ORIGIN OF THE PRAIRID PHYSICAL TYPE OF AMERICAN INDIAN

GEORG NEUMANN

THE racial history of aboriginal America, like its cultural development, presents some of the most interesting and, at the same time, most perplexing problems One of these is the origin and antiquity of the Indians of the Plains Before we can explain the origin of the physical types of this region attention must be called to the groups that we find peripheral to the area Morphologically these Indians can be classified into three primary racial types, not only on the basis of long series of crania from four archeological horizons but also on distributional evidence of racial divisions of living Indians Using for the primary races a terminology applied to the living Indians by von Eickstedt,[1] we identify a long-headed, high-vaulted, and relatively narrow-faced Sylvid group in the eastern woodland area, a round-headed, high-vaulted, somewhat broader-faced Centralid group in the southeastern states and the Southwest,[2] and a round-headed, low-vaulted (mainly because of a flat cranial base), large- and flat-faced Pacifid group in the Canadian Northwest Territories

Dixon[3] has shown that, to judge from its concentration in the

[1] Von Eickstedt, E, *Rassenkunde und Rassengeschichte der Menschheit* Stuttgart, 1934

[2] The Sylvid and Centralid racial types correspond to the Algonkin and Gulf types of Hrdlička (Aleš Hrdlička, "Catalogue of Human Crania in the United States National Museum Collections," *Proceedings of the United States National Museum*, Vol 69, Art. 5 1927), except that von Eickstedt includes the Indians of the Plains (Hrdlička's Siouan type), who form the subject of this paper, with the eastern dolichocephalic Sylvids Von Eickstedt's terms have been used in preference to Hrdlička's since the latter have linguistic and cultural connotations Thus we find Sylvid Siouans in Virginia, Centralid Siouans in Missouri, Northern Prairid Siouans in Minnesota, and Southern Prairid Siouans in Arkansas Hrdlička's terminology would present us with Algonquian Sioux, Gulf-type Siouans, Caddoan-speaking Sioux, Siouan Sioux, Siouan Algonkins, etc — terms that would without explanation be somewhat confusing

[3] Dixon, R B, *The Racial History of Man* New York Charles Scribner's Sons, 1923

extreme marginal portions of the continent, the oldest stratum of aborigines consisted of a number of long-headed types, and his deduction has been substantiated in many regions by archeological evidence This early population was at first widely distributed over immense tracts of continuous territory, and survived both as minor elements in later populations and as relatively homogeneous groups in marginal areas In the eastern United States the earlier prepottery-horizon Sylvids left extensive remains along the coasts of Maine and Georgia, in upper New York state, and in the ancient shell midden deposits along the river courses of western Kentucky, Tennessee, and Alabama

This same dolichocephalic population, with some variation in subtypes, continued into the next archeological horizon, in which the first pottery (fiber- and granular-tempered) made its appearance The horizon has been tentatively dated as circa 800–1100 A D The glacial kame burials of northwestern Ohio, the stone mounds along the Ohio River, and the Tchefuncte sites in Louisiana of this horizon yield crania which can be assigned to the Sylvid group But with the advent of the Adena culture in southern Ohio and Kentucky, the Red Ochre manifestation in Illinois, and the Vine Valley aspect in New York the first brachycranial element appeared. Its connections were with the Southeast The earliest known cranial material in the eastern Plains from Minnesota, Iowa, Nebraska, Kansas, and Missouri is Sylvid, and probably dates from this horizon. The crania from the Plattsmouth Group described by Poynter,[4] the vault graves along the lower Missouri and along the Mississippi in Illinois, and early Woodland sites in the other states can be included here

In the third horizon (perhaps between 1100 and 1400), during which the Marksville–Troyville, Hopewellian, Swift Creek, Early Weeden Island, and Copena cultures flourished, the racial composition did not change greatly All the earlier groups were probably long-headed Sylvids, only in the later stages of this horizon do Centralid elements become prominent in the North, especially in central Illinois and northwestern Indiana The eastern Plains are represented by the skulls from the Fort Lisa group,[5] which have been assigned to this period on the basis of the type of artificial deformation they

[4] Poynter, C W M, "A Study of Nebraska Crania," *American Anthropologist*, N S, 17 (3) 512–513 1915

[5] *Ibid*, pp 514–515.

exhibit, and by a number of series from Hopewellian sites scattered along the Mississippi and its tributaries from southeastern Minnesota to Oklahoma

Finally, during the fourth archeological period, sometime between 1400 and 1500, the inhabitants of the entire region covered by the southern states, except the Carolinas and Virginia, were replaced by Centralid peoples This population, entering the southeastern states through southern Missouri, Arkansas, and Louisiana, can be identified with the Muskogean-speaking tribes who, immediately before the discovery of America, expanded northward into Illinois and southern Wisconsin with a Middle Mississippi culture Undoubtedly some of the older long-headed peoples were absorbed by the Centralid newcomers, but other southern Sylvid tribes were pushed toward the northeast In peripheral regions these Centralids came in contact with different groups and in a number of instances gave rise to transitional cultures, as well as racially mixed populations Along the Missouri near Omaha Centralids were found in the Wallace Mound group associated with the Nebraska aspect of the Plains phase,[6] in Iowa and Wisconsin Centralids and Sylvids were the bearers of the Oneota culture, and in southern Ohio Sylvids and Centralids came in contact to give rise to the Fort Ancient aspect It is during these late prehistoric times that we encounter the first Plains Indian skeletal remains, close to the Mississippi River south of Minnesota

As for the Northwest Territories, although very little is known archeologically of the whole region extending from the Canadian northwest into the high Plains, it is virtually certain, as Dixon[7] has pointed out, that the Indians of this vast area formed essentially one great group Here too is evidence that the region was inhabited formerly by dolichocephalic types which were later replaced by Pacifids Originally this group, probably the most recent immigrants from Asia, underwent a change in head form and became more brachycephalic, but upon contact with dolichocephalic populations its advance guard gave rise to a hybrid that differed a great deal from both elements that helped to produce it. All evidence, especially as one proceeds south and eastward, points to this Pacifid-Sylvid mixture as a relatively recent happening. In the northern Plains the result of hybridization was a type with a comparatively

[6] *Ibid*, pp 510-512 [7] *Op cit*, p 423

long but low-vaulted skull, a heavy, relatively large, somewhat flat face, and a prominent nose The westward movement of originally Sylvid Algonquian tribes into the Plains in historic times may also have contributed a great deal to this mixture In the southern Plains, on the other hand, where the Pacifids came in contact with a Centralid type, the Pacifid–Centralid mixture resulted in a form with a similarly heavy face, but brachycranial and with a relatively high cranial vault I am calling these two types of Plains Indians Northern and Southern Prairids

On examining a wide range of crania of Plains Indians it immediately becomes apparent that as a whole they are morphologically far less homogeneous than one would suppose This was brought out by Dixon [8] when he attempted to classify them into his eight types, which were arbitrarily based on three indices He indirectly recognized the differences between such tribes as the Algonquian Blackfoot, Arapaho, and Cheyenne, the Siouan Assiniboin, Crow, Teton, Mandan, and Hidatsa, and the Caddoan Arikara and Pawnee, on the one hand, and the Siouan Ponca, Osage, Kansa, and Quawpa, the Caddoan Wichita and Caddo, and the Tonkawa on the other Hrdlička [9] presents additional evidence, but he limits his Siouan physical type to the group that I have called Northern Prairid and describes the type represented by the Osage as "plainly not Sioux, regardless of language and possibly some admixture " [10]

A detailed examination of all available cranial material from the Plains in which cognizance is taken of accompanying archeological data will throw much light on the racial history of this region, but it is already certain that we cannot distinguish a stabilized "Plains type" that would be typical of all the tribes with a Plains culture If we are to speak of a Prairid type we must recognise its tri-hybrid origin and its various degrees of regional differentiation based on the varying proportions of contributing elements

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[8] *Op cit*, pp 427–433 [9] *Op cit*, pp 50–79 [10] *Ibid*, p. 78.

INDIAN TRADE OBJECTS IN MICHIGAN AND LOUISIANA *

GEORGE I QUIMBY, JR

INTRODUCTION

VARIOUS trade articles manufactured in Europe and European colonies were acquired by historic North American Indians from traders, explorers, and missionaries in the seventeenth, eighteenth, and nineteenth centuries Their presence in an Indian site provides some evidence for the date of occupation because their chronology indicates the chronology of the associated native artifacts The dating of these articles is based upon the evidence of makers' marks and styles or their presence in a documented historic site It is possible, therefore, to obtain from the trade objects of a given site the date of the site as well as those of the objects themselves When a site is documented and also contains suitable trade materials the two factors complement each other and provide an ideal means for dating the native artifacts

In a previous paper I described the trade artifacts which were representative of the early and late historic periods in the upper Great Lakes region [1] The early historic period was from 1700 to 1760, the late one, from 1760 to 1825 It must be emphasized, however, that these dates represent a working hypothesis which may have to be modified

My present purpose is to compare the trade materials indicative of the early historic period in the upper Great Lakes region with those of the same period in the lower Mississippi Valley and to show the similarities between them, despite the considerable geographical separation of their provenences There are data from four different

* This paper was prepared with assistance from Louisiana Work Projects Administration Official Project No 165-1-64-59.

[1] Quimby, George I , Jr , "European Trade Articles as Chronological Indicators for the Archaeology of the Historic Period in Michigan," *Pap Mich Acad Sci , Arts, and Letters*, 24, Part IV (1938) · 25–31. 1939

Indian sites of the early historic period, one in Michigan and three in Louisiana, and all four sites were occupied when French influence was dominant

THE SITES

The upper Great Lakes material was collected from the site of Fort St Joseph near the city of Niles, in Berrien County, Michigan The fort was established and maintained by the French from shortly after 1700 until 1760 Near it were two Indian villages, one Miami, the other Potawatomi Therefore the trade artifacts from the environs of the fort should constitute a part of the material culture of the Miami and Potawatomi tribes as they existed in the early historic period [2]

The trade artifacts from the lower Mississippi Valley came from two historic Indian villages in Louisiana and one in Mississippi The first of these is the Angola farm site in West Feliciana Parish In the early historic period it was probably occupied for the most part by Tunicas [3] Archeological investigations of the site by James A Ford produced many trade objects accompanied by numerous artifacts of native manufacture which were diagnostic of the Natchezan culture type [4]

The second Louisiana site is a former Bayogoula, Mugulasha, and Taensa village in Iberville Parish The known period of occupation was from 1699 to 1706, although there were probably intermittent occupations by remnants of these tribes and others until 1758 [5] Investigations of this site also produced trade objects along with native artifacts which were of the Natchezan culture type.

Excavations at the Fatherland plantation near Natchez in Adams County, Mississippi, have been described by Ford European trade objects were found in association with Natchez artifacts This site is probably the Grand Village of the Natchez, which was occupied from at least 1699 to 1730 [6]

[2] Quimby, *op cit*, pp 25–26

[3] Ford, James A., *Analysis of Indian Village Site Collections from Louisiana and Mississippi*, pp 129–140 Anthropological Study No 2, Department of Conservation, Louisiana Geological Survey, New Orleans, 1936

[4] Ford, *op. cit*, p 140, and Quimby, G. I, Jr, "The Natchezan Culture Type," *American Antiquity*, 7 (1942) 255–275

[5] Swanton, John R, *Indian Tribes of the Lower Mississippi Valley and Adjacent Coast of the Gulf of Mexico*, pp 274–279 Bureau of American Ethnology. Bulletin 43, Washington, 1911

[6] Ford, *op cit*, pp 59–65

THE TRADE OBJECTS

Glass Beads

The sites in both Michigan and the lower Mississippi Valley contained identical types of Venetian glass beads The glass or porcelain beads traded to the Natchez have been described by Le Page du Pratz, a French writer [7] who lived among these Indians in the first quarter of the eighteenth century His account is not very specific, but among the beads he mentions were some like those found in these early sites The various types and their distribution are recorded in Table I

Glass Containers

The introduction of glass bottles into the lower Mississippi Valley must have occurred prior to 1700, for a "double glass bottle" was seen in a Bayogoula temple by Iberville in 1699 [8] Fragments of Dutch gin bottles (Pl I, Fig 20) were found only at the Bayou Goula and the Angola farm sites Large rum bottle fragments (Pl I, Fig. 19) have been recorded, however, from all the sites discussed in this paper, but fragments of blown glass tumblers were discovered only at the Bayou Goula site

Earthenware

Fragments of glazed and unglazed crockery jugs and bowls (Pl I, Fig 21) are represented in all the sites considered French polychrome earthenware (Pl. I, Fig 22) and earthenware with appliqué design have been obtained at the Fatherland plantation, the Angola farm, and Fort St Joseph Slightly different polychrome earthenware has been recorded for the Fatherland plantation, Bayou Goula, and Fort St Joseph sites And a Staffordshire-like earthenware (Pl I, Fig 23) has been found at all the sites Perhaps this style of pottery represents a later introduction of British origin It is not inconceivable, however, that English pottery was distributed by the French

Pipes

White-clay molded trade pipes, with round, flat-bottomed spurs, were discovered at all four sites Examples with "TD" or

[7] Swanton, *op cit.*, pp 55–56 [8] Swanton, *op cit.*, p 275.

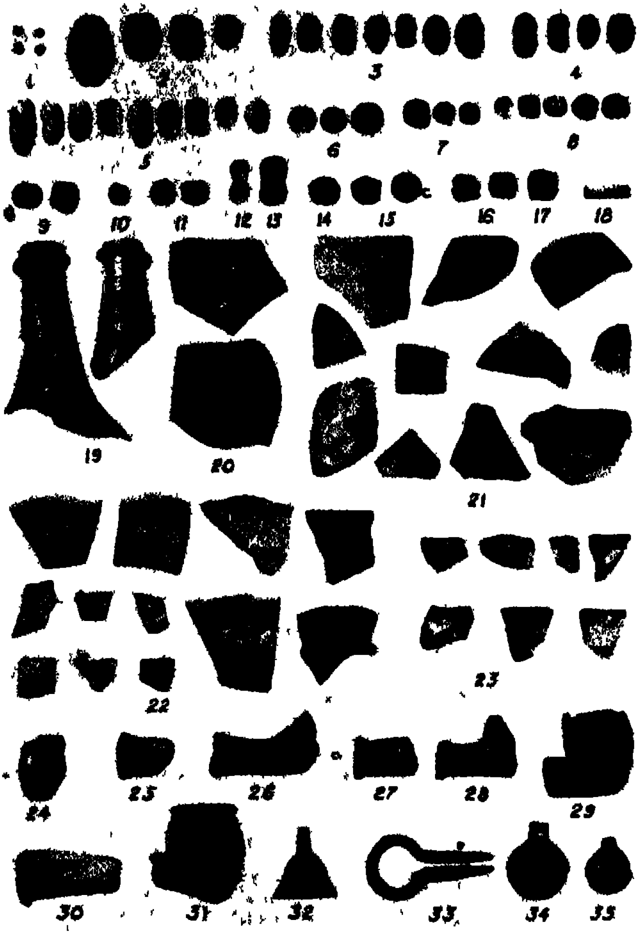
TABLE I

TYPES OF BEADS AND THEIR DISTRIBUTION

Styles of beads*	Fort St Joseph	Angola farm	Bayou Goula	Father-land plantation
Seed				
Colorless		+		+
Monochrome (Pl I, Fig 1)	+	+	+	+
"Cornaline d'Allepo"		+		+
Elongate-spheroidal				
Colorless (Pl I, Fig 2)	+	+	+	+
Monochrome (Pl I, Fig 3)	+	+	+	+
Polychrome (Pl I, Figs 4–5)	+	+	+	+
Oblate-spheroidal				
Colorless (Pl I, Fig 6)	+	+		+
Monochrome (Pl I, Fig 7)	+	+	+	+
Polychrome (Pl I, Fig 8)	+	+	+	+
"Gooseberry" (Pl I, Fig 9)	+	+		
"Cornaline d'Allepo" (Pl I, Fig 10)	+	+		+
Oblate-spheroidal-joined				
Monochrome (Pl I, Fig 12)		+	+	+
Polychrome (Pl I, Fig 13)	+	+		
Oblate-spheroidal-fluted				
Monochrome (Pl I, Fig 11)	+	+		+
Decahedral				
Colorless (Pl I, Fig 14)	+	+		
Monochrome (Pl I, Fig 15)	+	+		
Raspberry-shaped				
Colorless (Pl. I, Fig 16)	+	+		+
Monochrome (Pl I, Fig 17)	+	+		
Tubular				
Monochrome	+		+	
Polychrome (Pl I, Fig 18)		+		+

* Cf Orchard, Wm. C, "Beads and Beadwork of the American Indians, a Study Based on Specimens in the Museum of the American Indian," *Contributions from the Museum of the American Indian, Heye Foundation*, Vol XI.

"RT" stamped on the bowl are in the collections from the Angola farm and Fort St Joseph A few of the pipes at Fort St Joseph have pointed spurs, mushroom-shaped spurs, and appliqué stamped designs, variants which do not occur in the lower Mississippi Valley sites Iron-tooled stone Micmac pipes, on the other hand, are



Indian trade objects of the early historic period

Figs 1-18, glass beads, Figs 19-20, glass bottles, Figs 21-23, earthenware, Figs 24, 26, 28, trade pipes, Figs 25, 27, 29-31, aboriginal pipes, Fig 32, small dinner bell, Fig 33, jew's-harp, Fig 34, small hawk bell, Fig 35, lead fabric seal

diagnostic of material culture at Fort St Joseph as well as catlinite and pewter "peace pipes" A style of pipe with a glazed pottery bowl (Pl I, Fig 24) was found only at the Bayou Goula site Short-stemmed dark-clay trade pipes manufactured in Marseille (Pl I, Figs 26, 28) have been collected from the surface of a historic site in Point Coupee Parish, Louisiana, and although these are not from one of the historic sites in question, they are presented here because of their typological relationship with native pipes that come from Bayou Goula (Pl I, Figs 25, 27, 29–31)

Objects of Brass or Copper

Brass or copper kettles were present at these early historic sites in both Michigan and the lower Mississippi Valley More common artifacts, however, were cut and hammered fragments of brass kettles All four sites yielded objects of brass, such as disk buttons with rings for attachment, hollow spheroidal buttons with rings for attachment, thimbles, and coiled-spring ornaments Du Pratz described these ornaments and the way they were worn [9] A circular copper gorget with two perforations accompanied a burial at the Fatherland plantation Brass or copper tinkling cones and hawk or Morris bells (Pl I, Fig 34) are reported from all four sites and, according to the journal of the frigate *Le Marin*, the Bayogoula and Mugulasha had tinkling cones as early as 1699 [10] Hawk bells worn by the Natchez are mentioned by Du Pratz [11] Brass dinner bells (Pl. I, Fig 32) have come from the Bayou Goula site and the Angola farm Sheet-brass C-shaped bracelets occurred only at the Angola farm, although brass-wire bracelets of similar shape are listed for all four sites. Triangular sheet-brass projectile points were common in the Fort St Joseph collections, but have not been recorded for any of the lower valley sites discussed in this paper

Iron Objects

Jew's-harps (Pl. I, Fig. 33) were found at the Angola farm in Louisiana and at Fort St. Joseph in Michigan. These musical instruments, however, are also representative of the late historic period, at least in the upper Great Lakes region.[12] Iron clasp knives [13]

[9] Swanton, *op cit*, p 55 [10] *Ibid*, p 276. [11] *Ibid*, p 127

[12] Quimby, p 30 of article cited in note 1

[13] *Ibid*, p 27, and Plate II.

and butcher knives were collected at all four sites According to Iberville, the Bayogoula and Mugulasha Indians had knives as early as 1699,[14] probably they were pretty well distributed throughout the lower Mississippi Valley by that date Iron-wire C-shaped bracelets and scissors were unearthed at both the Angola farm and Fort St Joseph Iron axes with loop hafts have been listed from the Angola farm, the Fatherland plantation, and Fort St Joseph Documentary evidence of the existence of iron axes in the lower valley has been found by Swanton in the writings of Iberville and of Du Pratz, who stated that these axes were made by the French and had a blade three inches long[15] Iron hoes with loop hafts were present at both the Fatherland plantation and Fort St Joseph

Such articles as caltrops, fishhooks, triangular projectile points, awls, saws, tomahawk pipes, and needles have been reported only from Fort St Joseph Iron needles, however, were known in the lower Mississippi Valley in the early historic period, for some were given to Bayogoula and Mugulasha by Iberville in 1699[16] The only example of an iron halberd came from a burial at the Angola farm All the sites contained iron nails, but flat oval strike-a-lights occurred only at the Angola farm and Fort St Joseph A rather unusual iron kettle with three legs was found at the Fatherland plantation

Flintlock Guns

Although the archeological evidence indicates that the historic Indians of the lower valley had flintlock guns, it is interesting to note that both De Montigny Dumont[17] and Le Page du Pratz[18] specifically mentioned them as articles of trade Nearly identical flintlock guns have come from the Angola farm, Fort St. Joseph, and the vicinity of the Fatherland plantation The barrels are octagonal in section at the breech, and the brass butt plates have a narrow ornate spur, which was fastened to the top of the stock Brass trigger guards have a shaped and engraved fleur-de-lis or similar design at the distal ends, it and the section of the guard which covered the trigger are engraved with enclosed rectangles Brass ramrod leaders, which are hexagonal, have a long, narrow tang, the brass side plates consist of a central shield with openwork at either side The bat-

[14] Swanton, *op cit*, p 275 [16] *Ibid.*, pp 66, 127, 275.
[15] *Ibid*, p 275 [17] *Ibid*, p 90 [18] *Ibid.*, p. 69

teries or frizzens are plain and undecorated Lead balls of slightly variable size are common at all sites Gun flints, which are plano-convex or trapezoidal in cross section, have been recorded for all sites Some objects, however, occur only in collections from Fort St Joseph These are iron butt plates with saddlebacks, solid side plates of brass, some of which were engraved, and brass side plates shaped like conventionalized dragons A different type of butt plate excavated with a burial from the Angola farm was made of iron and has a short spur to fit over the upper butt end of the stock Iron trigger guards were found only at this site The gunlocks themselves, although damaged and encrusted, are similar in both the northern and southern areas

Religious Objects

Collections from Fort St Joseph included brass or bronze medals stamped with pictures of saints, prayers, and religious phrases, brass finger rings engraved with religious devices, brass crucifixes, brass crosses, and lead crosses [19] No similar artifacts have been found at Bayou Goula, the Fatherland plantation, or the Angola farm, although the possession of medals and rosaries by early historic Indians in the lower Mississippi Valley was mentioned by Paul du Poisson in 1727 [20]

Coins and Fabric Seals

By virtue of the dates stamped upon them coins and fabric seals are particularly important in determining the chronological position of historic sites In 1721 Charlevoix mentioned that the Tunica chief dressed like a Frenchman and hoarded money, and that he was "reckoned very rich [21] This statement suggests that the use of coins was rather common A French colonial coin dated 1722 was excavated from a pit in the Bayou Goula site, and another French coin with the date 1677 forms part of a collection from Fort St Joseph.

Lead fabric seals were probably attached to the cloth and blankets which were introduced into the lower Mississippi Valley during the early historic period by the French Both Du Prats and Dumont mentioned the use of blue and red Limbourg for clothing by the Indians of the lower valley.[22] A lead fabric seal (Pl I, Fig 35) from

[19] Quimby, Plates I–II of article cited in note 1
[20] Swanton, *op cit.*, p. 313 [21] *Ibid.*, pp 312–313 [22] *Ibid*, pp 52–53

the Bayou Goula site was too badly eroded to enable me to determine a date or an inscription, but its association with other trade objects and the documentary evidence for the existence of cloth in the area suggest that the seal belongs to the early historic period Similarly shaped lead seals from the Fort St Joseph collections are dated from 1734 to 1746 [23]

Miscellaneous Trade Objects

Powdered vermilion has come from all four sites Its presence among Indians of the lower Mississippi Valley in the early historic period is confirmed by Dumont [24] Only in the Fort St Joseph collections, however, are there shell runtees, although ornaments of catlinite are found at the Angola farm, the Fatherland plantation, and Fort St Joseph

SUMMARY AND CONCLUSIONS

Despite the distance between the Fort St Joseph site in Michigan and the sites in the Lower Mississippi Valley the same types of trade objects occur in both areas The reasons for this phenomenon are two (1) Both sites belong to the early historic period, and (2) both areas were under French domination during this period

Probably a number of these trade objects indicate only the historic period in general There are, however, other artifacts which seem to be characteristic of the early historic period Some of them are the various bead types, with the exception of seed beads, which persist throughout the historic period, coins, fabric seals, types of glass bottles, types of earthenware, types of knives, and certain styles of flintlock guns Of course, it is possible for any or all of these objects to occur in a late historic site, but they would probably be associated with other trade objects known to be diagnostic of the late period In addition, there are certain early historic trade objects which may be indicative of the area as well as of the period. For instance, the shell runtees, iron-tooled Micmac pipes, metal triangular projectile points, and other things were found only in the Fort St Joseph collection and, therefore, are representative of the early historic period at that place. On the other hand, such objects

[23] Quimby, p. 27 and Plate I of article cited in note 1.
[24] Swanton, *op cit*, pp 54, 90.

as iron halberds and French elbow pipes are perhaps diagnostic of the same period in the lower valley

There is the additional probability that early historic sites in areas dominated by the British or the Spanish will have an entirely different complex of trade objects indicative of periods and areas For this reason the dating of historic sites by means of trade articles should be undertaken cautiously and with a knowledge of the area, the dominant European nationality, the archeology of the historic sites, the documentation of the sites, and the chronology of the trade objects

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LITHIC PATINA AS AN AGE CRITERION

ELMAN SERVICE

IN THE literature of archeology in both Europe and America certain surface alterations on stone artifacts have been interpreted as evidence of great antiquity These alterations have usually been described as "patina"[1] There are archeologists today who have dissented with this view and who feel that the blanket assertion that the presence of patina means great age is naïve and ill-founded Little agreement, however, is manifest among these archeologists as to what its presence really does mean No one, apparently, has taken the trouble to publish a bibliography on the subject, and the writings of those few who do have a positive opinion about the nature of patina are more conjectural than scientific That a very confused state of affairs exists in this respect is clearly indicated by the fact that the authors who have the most to say about patina often do not even refer to the same *kind* of phenomenon in their use of the term

A rather noteworthy fact is apparent in looking over archeological literature Those who consider the presence of patina a reliable criterion of age make, as a rule, very little comment about it except for noting its presence It is among those authors who disagree with this concept that are found the few positive statements concerning the nature of surface change

An Englishman, H Dixon Hewitt (6), has contributed the most notable work on the subject among the European students He experimented carefully and demonstrated that there are many *kinds* of chemical action on stone which can change the surface color or

[1] According to *Webster's New International Dictionary* (1934), patina is "A film, usually green, formed on copper and bronze by long exposure to a moist atmosphere, or by treatment with acids, etc It is a basic carbonate of copper protecting the metal from further oxidation . . By extension, a film similarly formed on other metals, or the surface appearance assumed by various materials, as wood, marble, etc , after long exposure" The term "patina" has been long used in classical archeology in strict accordance with this dictionary definition Nowhere, however, to the best of my knowledge, have archeologists in the Near Eastern field used it as a criterion of age

structure Oxides of iron and manganese may be present in a soil to color the surface of a stone, and alkaline solutions — the chief of which are potash, soda, and ammonia — may also be active, as may alkaline chlorides Investigation showed that at least four factors affect the amount of surface change a given chemical is able to induce the length of time a rock is exposed to the chemical activity, the temperature, the concentration of the chemical agent, the initial condition of the stone It is possible, of course, that in nature there are still other influences to consider It seems obvious, inasmuch as the time element is one variable among four or more others, that chemical change on the surface cannot have any absolute value in determining age Mechanical change of surface due to certain kinds of abrasive action quite naturally depends on so many different specific circumstances as to be of even less value as evidence of antiquity

Additional types of surface change have been described by other English authors who, like Hewitt, do not accept the mere presence of patina as evidence of great antiquity W. J Sollas (11) mentions that pure silica carried in solution may be deposited as a sort of thin film on the surface of a stone This results in a brilliant polish He also notes a similar kind of change in flint, which he defines as a granular mixture of quartz and opal Underground water may dissolve away some of the opal and leave a very thin film of pure quartz granules If the flint is of the black variety, the well-known "blue patina" appears

M C Burkitt (5) describes flint as silica containing in loose combination a variable quantity of water In some circumstances moisture may be given off, leaving a thin skin of colorless silica on the surface. The blue patina is due to this film lying over the black flint Iron salts may become absorbed into the film and color the flint surface an ochreous yellow or orange. However (to quote Burkitt), "It must be borne in mind that the formation of patina is very capricious and results from conditions as yet imperfectly understood No great antiquity can be postulated for a specimen simply because it is deeply patinated" Edgar Willett (14), like Burkitt, considers patina to be a glossiness resulting from the deposition of a film of pure silica on the surface of flint, whereas Leslie Armstrong (2) thinks it is a thin mineral film laid down in the evaporation of moisture which carried mineral substances in solution.

French archeologists have become greatly interested in patination in the last few years On the pages of *L'Anthropologie* are recorded many controversies as to whether a consideration of patina has value The staunchest upholder of the "pro" side of the question, the Abbé Breuil (3), makes no claim, however, that patina has any value as a criterion of age He believes it should be studied carefully because degrees of patination on two typologically dissimilar groups of artifacts may indicate that the two groups had been stratigraphically separated

Other French writers, working with European paleoliths, have refused to concede that patina has any value at all René Verneau (12, 13), for example, has been very forceful in his denunciation of patination studies

In America archeologists have often considered these surface alterations on stone artifacts to be evidence of great antiquity N H Winchell (15) argued in 1913

> The patination of flint is accepted in Europe as an indication of great age When found on similar artifacts in America it has the same significance Not only do European specimens show the well-known patination indicative of Paleolithic date, but African and Asiatic stone implements, when they possess this evidence, also are classed uniformly with European Paleoliths.

George Grant MacCurdy (8) seems to make the same assumptions For instance, he describes in detail the patina of paleolithic industries as though it had some absolute value in dating particular groups of artifacts.

Many writers, even though perhaps more cautious than Winchell, nevertheless consider the presence of patina indicative of great age Edgar Howard (7) has said that the term "patina" should be used with discretion, but he regards the patina found on the Folsom points as evidence of at least moderate antiquity. Charles Avery Amsden (1) says that inasmuch as patina is known to occur slowly it is therefore of some value, although in a qualified sense

Other American writers have exhibited a certain distrust of this use of the concept N. C Nelson (9) writes that while patina is undoubtedly a valuable criterion of age, it is difficult to deal with effectively because the processes involved are not constant and so make comparative studies next to impossible Malcolm J Rogers (10) believes that variation in amount of patination may not be entirely due to age differences.

Many authors in the American field refer to the term in passing, but say nothing definite about it Even Kirk Bryan (4), a geologist, fails to discuss the significance of the patina he describes in one of his archeological reports

It is readily apparent that American archeologists, compared with certain Europeans, know very little about the nature of patina For that reason we are bound to turn to Europe for the most definitive investigation of this subject The experiments of Hewitt (6) on chemical alteration demonstrate very well that patina should not be considered a criterion of antiquity Inasmuch as his work is by far the most comprehensive examination of the chemistry of the subject, we are obliged to accept his conclusions in preference to the conjectures of other men In justice to the English and French archeologists in general, however, it should be stated that Hewitt's findings do not tend to contradict their opinions The chief criticism must be leveled against Americans, who seem to have assumed, without foundation, that patina has proved fruitful as an age determinant in Europe

Yet the fact that patina has little value in ascertaining age does not mean that it has no use at all, as some archeologists appear to have concluded As mentioned before, the Abbé Breuil (3) suggests a valuable application for patination studies He is supported in this by Burkitt (5), who considers that differences in patination correlating with typological dissimilarity may be good supporting evidence that two separate industries are represented, differences in patina may indicate stratigraphical differences

Another possibility is suggested by Sollas (11) Should it be difficult to discern whether a given stone is a bona fide artifact, patina may in some instances provide a clue If all the chipped surfaces were formed at the same time, as is true of a genuine implement, they should all be more or less equally patinated. If the surfaces were chipped at several widely separated intervals, as may sometimes happen when the chipping was done through natural agencies, the surfaces may be unequally patinated. Patina in this situation cannot, of course, be considered of absolute value, but it may be useful in specific circumstances if intelligently employed

There is a third way in which consideration of surface change has proved fruitful A glossy finish occurring on the working edge of a tool may indicate that the tool was in use at one time That

abrasive action often results in just such a finish can easily be shown with a polishing wheel Sometimes an implement that has been hafted and then used may exhibit this gloss on the part of the stone where the handle was attached

It cannot be too strongly emphasized that there is a special danger involved in the use of the term "patina" It is a single word which designates many different *kinds* of surface change A considerable number of writers have been guilty of employing "patina" as though it were a well-understood and precise concept The reader is often unable to decide whether the term refers to a mechanically induced gloss, a "desert varnish," a corroded surface, a stain of some sort, or ordinary weathering This word has such a wide indefinite usage at present that it is especially necessary to determine just what kind of surface change is being called "patina" in any particular instance

A real and immediate need exists for comprehensive experimental work on the subject of surface alteration of flint After more is known of the nature of such change, there is no apparent reason why patination studies should not be employed for a variety of purposes It is even possible that patina may in the future prove worth while, in combination with other criteria, as an indication of age Until then, however, its presence should be interpreted only in the three ways previously mentioned

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THE IMPERSONATION OF SAINTS AMONG THE PUEBLOS

LESLIE A WHITE

THE first white men who saw the Indian pueblos of the Rio Grande Valley in New Mexico were Coronado and his followers in 1540 The first Spanish colony was founded in this region some sixty years later For many decades after the conquest there was much friction between the Pueblo Indians and their Spanish overlords The clergy tried to stamp out the native religion and to convert the Indians to Christianity The Indians resisted conversion and clung tenaciously to their old ways In 1680 the great Pueblo revolt broke out All Spaniards were either killed or driven from the country But, of course, they came back, and before the end of the seventeenth century the Pueblos of New Mexico had again been subjugated.

The Indians now tried a new course It was clear that the Spaniard was there to stay, some way had to be found to live with him With regard to religion the natives devised a very satisfactory mode of adjustment On the one hand, they developed highly successful means of concealing their religious life from the Spaniards And, on the other hand, they accepted certain elements of Christianity from the Spanish padres The remarkable thing about this arrangement was that the Indians did not become Catholics, but elements of Catholicism became Indian That is to say, the natives, while appearing to accept Christianity, merely took over certain of its concepts, bits of paraphernalia and ritual, and incorporated them in their own religious system

Catholic saints became Indian gods, as is indicated by the fact that they belong to a definite class of spirits in the native pantheon called *maiyanyi*.[1] The Pueblo Indians distinguish several kinds of supernatural beings, such as *kachinas*, *kopishtaiya*, *kanadyaiya*, and *maiyanyi* To the native, the Catholic saints are simply *maiyanyi*,

[1] This and other native terms in this essay are of the Keresan language

along with such aboriginal supernaturals as Arrow Youth, Spider Grandmother, and Buzzard Old Man

Every pueblo in New Mexico has a Catholic patron saint who is represented by an image in the local church, and his, or her, day is celebrated with a mass conducted, of course, by a Catholic priest, and with a native Indian dance under the direction of the Pueblo war priest In addition to this, Catholic saints are frequently impersonated in ceremonies

In spite of the fact that the impersonation of saints is a conspicuous feature of some of the very few ceremonies which white people are permitted to see, this subject has received remarkably little attention from ethnologists It is mentioned casually here and there in the literature,[2] but I know of no study devoted especially to it. And, so far as I know, only one illustration of an impersonation has been published[3] prior to the one here presented The distribution of this rite is not well known It occurs among all the Keresan pueblos and among some if not all of the Tewa villages Whether it is found among the Tiwa and at Jemez I cannot say The Hopi Indians do not practice it, and it is probably absent at Zuni In short, it seems to be found only in those pueblos which remained under Spanish control after 1680 It is a noteworthy fact that Santiago is impersonated by certain Aztec groups in Old Mexico much as he is in New Mexico[4] We are still far from having a complete or an adequate account of this interesting and important aspect of Pueblo ceremonialism

The saint who is impersonated most frequently is Santiago San Geronimo, and perhaps others, are represented also One of the *maiyanyi* saints who appear as characters in Pueblo ceremonies is named Bóshaiyanyi The significance of this word is not known It appears to be of Indian origin But, to all appearances, the impersonation of Bóshaiyanyi does not differ from that of saints with Spanish names Bóshaiyanyi seems to be but another example of the fusion of Catholicism with the native religion

Saints are always impersonated on horseback The horse is not

[2] Cf White, Leslie A, *The Pueblo of Santo Domingo*, Memoir 43 (1935), Am Anthropol Assn, pp 149–155, Goldfrank, Esther S, *The Social and Ceremonial Organization of Cochiti*, Memoir 33 (1927), Am Anthropol Assn., p 46.

[3] White, *op cit*, fig 42, p 151

[4] Starr, Frederick, "Notes upon the Ethnography of Southern Mexico," *Proc Davenport Acad of Natural Sciences*, 9 70. 1901–03

FIG 1 The impersonation of a saint at San Felipe Pueblo

a real one, but a small imitation, made of wood, horse hide, and cloth It is attached to, and encloses, the body of the impersonator, so that the illusion of horse-and-rider is created (Fig 1)[5] The saint's costume varies in details Sometimes he wears a crown, sometimes a hat, his face, below the eyes, may be covered with a kerchief, or it

[5] I am indebted to a friend, who wishes to remain anonymous, for the fine drawing in Figure 1 It represents one of the two saints witnessed by us at a war dance at San Felipe Pueblo on a Christmas day

may be exposed He usually carries a sword in his right hand. In his left he customarily holds a cross or a bow and arrow The horse has a mane and tail of real horsehair, but he has no legs A long robe rather effectively conceals this lack, however, and gives the illusion of a caparisoned horse The moccasined feet of the impersonator are fully exposed to view This absence of realism seems not to be an objection, however, but is perhaps desired, since the actor dances during the ceremony

The "horses," which are of Indian manufacture, are kept in the pueblo year after year, each with its own special custodian They are, without doubt, thought of as animate, as possessing a supernatural essence, like other sacred paraphernalia

The impersonation of saints does not occur regularly at stated occasions, but only when someone, always a man, pledges himself to perform this ritual If a man, or a close relative, has been having much sickness or "bad luck," he may pledge himself to impersonate one of the saints in the hope and expectation that, as a consequence, he will receive *ianyi*, i e beneficent supernatural power Such a person need not make public the reasons for his vow, but must at once notify the war priest of his decision From that time on the matter becomes a public, communal affair, under the direction and control of the war priest

Considerable time and preparation are required for the coming event The impersonator-to-be must outfit himself completely with new clothes He must secure, from its custodian, permission to use one of the horses He must practice wearing the horse costume and dancing in it In some instances, at Acoma, for example, he must make a grand tour of many pueblos, collecting at each one seeds of various kinds and bits of dung of domestic animals, these will be distributed during the ceremony

The occasions upon which the *maiyanyi* saints appear are Santiago's day (July 25), the day of the patron saint of the pueblo concerned, at Christmas, and possibly at other times The ceremony itself varies with the occasion and from pueblo to pueblo Sometimes one or more saints may come out on Santiago's day. When this occurs, the ceremony of impersonation is the principal event of the day, although it may be followed by a *gallo*, or "rooster pull" Sometimes the saints take part in the ceremonies held in honor of the pueblo's patron saint At Santo Domingo two saints appear as

characters in the Sandaro drama At San Felipe at Christmas I once saw two in connection with an *Opi*, or warriors', dance

At Santa Ana, Santiago and Bóshaiyanyi occasionally come out on Santiago's day In the morning the men who are to impersonate these saints go to the house of the sacristan (an Indian) where their horses have been kept during the period of preparation and rehearsal They don their costumes, "mount" their horses When they go out Santiago and Bóshaiyanyi are accompanied by the sacristan and his *teniente*, Masewi and Oyoyewi, the two war priests, by a *tcapiyo*, a masked man with a whip who keeps spectators from coming too close to the saints, and by the *kahera*, an official in ceremonies of Spanish derivation who beats a drum of European type

The saints and their attendants proceed to the Catholic church Santiago and Bóshaiyanyi ride their horses into the church, where they attend a Catholic prayer service conducted in Spanish by the sacristan Most of the men and older boys of the pueblo also attend the service They arrive at the church on horseback, on real horses, dismount, and enter

When the service is over everyone goes outside, and a procession is formed The *dapop* (governor) and his *teniente* are in the lead Then come the war priests, followed by Santiago and Bóshaiyanyi, riding abreast The sacristan walks on the outside of one of the saints, his lieutenant on the outside of the other The *tcapiyo* walks behind, or alongside, the saints with his big whip to see that no one approaches too close to them The *kahera*, too, walks near the saints, beating his drum The *fiscale* mayor and his lieutenant, Indian officials connected with the Catholic church of the pueblo, come next Men and boys, on horseback, bring up the rear, firing guns into the air at intervals The church bells are rung continuously by the *fiscale's* assistants during the procession through the pueblo

Santiago and Bóshaiyanyi and their entourage go to the big horse corral on the north side of the pueblo The men and boys in the party dismount and put their horses in the corral Then Santiago and Bóshaiyanyi, accompanied by the sacristan and his assistant, enter it Each saint hands his sword to his sacristan attendant and receives an aspergillum in return Santiago and Bóshaiyanyi now ride about among the horses sprinkling them with holy water, dipping their brushes in bowls held by the sacristans

When all the horses have been sprinkled, the men and boys again mount, the procession reforms, and, taking a circuitous route about the pueblo, goes eventually to the plaza Here Santiago and Bóshaiyanyi again sprinkle the horses and people Then they dance to several songs, after which the saints, again in procession, return to the church for a second prayer service This concludes the ceremony Santiago and Bóshaiyanyi return to the sacristan's house, where they "dismount" and remove their costumes

Santiago and Bóshaiyanyi occasionally assist in the ceremony held in honor of the patron saint at Santa Ana They enter the church at the conclusion of the mass [6] and take their place in the procession which is to conduct the image of Saint Anne from the church to the plaza They dance as the procession winds its way through the pueblo People come up to them, sprinkle saints and their horses with *petana* ("sacred meal"), rub their hands upon the horses, or try to pluck hairs from their manes or tails This is to obtain *ianyi* ("beneficent supernatural power") from them Money, kerchiefs, and other small gifts are thrown to the saints by the spectators They are picked up by the attending *trapiyo* and given to the actors at the conclusion of the ceremony After the image has been deposited in the house built for it in the plaza Santiago and Bóshaiyanyi go to the corrals on the outskirts of the pueblo, where they ride among the horses gathered there for this occasion, sprinkling them with holy water

The men who impersonate the saints do not keep the gifts which are thrown to them during the ceremony They are obliged to take them out into the hills, together with the new clothes Here they deposit them, presumably at a shrine, as a sacrifice or an offering to the *maiyanyi* saints

The ceremonies and rituals of impersonation at other pueblos vary in details But so far as our data go, the essential features are the same

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[6] The Catholic priests, sensing the pagan character of these "saints," have occasionally tried to exclude them from the church and from the procession to the plaza

HISTORY AND POLITICAL SCIENCE

THE DEVELOPMENT OF COAL MINING IN FRANCE, 1815–48

ARTHUR L DUNHAM

THE development of coal mining in France was of little importance before 1815, partly because the necessary means of transportation were not available and partly because there was little demand for it by either industrial or domestic consumers The use of coal in smelting and refining iron had not begun, for the country had been able to obtain a fairly adequate supply of iron goods through importation and still more through manufacture with wood, which was available in reasonably sufficient quantities Furthermore, most of the coal deposits were too small or inaccessible to be important, and the majority were on or near the borders of the Massif Central

The great basin of coal in the Department of Nord, a continuation of the deposits of the Ruhr and of Belgium, is the only important one not in central or southern France In production it ranked next to the basin of the Loire Yet it was difficult to mine because the coal was generally far below the surface, indeed, what is now the richest part of that coal field, the basin of Pas-de-Calais, was discovered only at the end of the period 1815–48, because as the veins of coal continued westward they sank ever deeper and then suddenly turned sharply northward toward the English channel The part of this great northern coal field which was mined effectively in the earlier nineteenth century was the northeastern portion in the Department of Nord, known as the basin of Valenciennes

Much of the coal available in France between 1815 and 1848 was thus in hilly or mountainous districts in the central part of the country or in the south. Almost all of it was far from any useful deposits of iron, or, if not far away in actual distance, was so in effect because of the lack of cheap means of transportation None of the French coal mines was close to a really good seaport and few were near the sea. The most productive basin of our period, the Loire, was between two of the greatest French rivers, but they were difficult and costly

to use, because the Loire was full of rocks in its upper reaches and of sand bars in its middle course, and the flow of water was irregular, whereas the Rhone had an unusually strong current and ran to the south, away from the most important markets Artificial waterways were much used in France and were greatly developed under the Restoration and July Monarchy, but they were usually narrow and shallow in the central part of the country and scarcely existed in the south The cost of adapting them to large shipments of coal would have been enormous Only in the north were the rivers and canals formed into a system of waterways that could carry great quantities of coal economically, and there the only supply within the country was the basin of Valenciennes The deposits of coal in France were thus so placed that they did not make easy or economical its use in manufacturing Northern France alone had its own supply, yet that was too frequently expensive because waterways could not reach all the many industrial centers and the cost of carting was almost prohibitive

It is not surprising to find that in 1815 the production of coal in France was only 882,000 tons, importations, 249,000 tons, and consumption, 1,112,000 tons But in 1847 consumption had grown to 7,000,000 tons, production to 5,000,000, and importations to 2,000,000 [1] In general the rise in the use of coal corresponded to the industrial development of France, especially to that of the iron industry, and was promoted also by the improvement of transportation and the marked reduction in the duties on importations of coal in 1836 Because of all these factors the demand for coal became so great under the July Monarchy that not only were there no serious complaints against the use of foreign coal, whose rate of increase was considerably greater than that of domestic production, but the consumption of coal did not decrease appreciably even during industrial depressions, as did that of most other commodities, except during the economic crisis that accompanied the Revolution of 1848

France produced numerous varieties of coal in the period 1815–48, this has been emphasized by a number of French writers, but in practice it was not a fact of great importance, because the only basins that were able to ship coal for long distances were those of the Loire, Saône-et-Loire, and Valenciennes Inadequate means of transporta-

[1] Simiand, François, "Essai sur le prix de charbon au XIXe siècle en France," *Année sociologique*, 1900–1901, pp 17, 25

tion and high prices to the consumer were nearly always decisive Most mines were compelled to sell to local markets exclusively, and the concentration of industry on a large scale would have been prevented by these factors, had the tendency to it existed in any marked degree

The cost of mining in the really important French basins averaged considerably higher than in England and about the same as in Belgium, for, although costs in the basin of St Étienne in the Loire and Blanzy in the Saône-et-Loire were about the same as in the basin of Newcastle and less than in Lancashire, they were much higher in the basin of Valenciennes than in the more expensive of the two great basins of England Costs in France were raised by the irregularity in both slope and direction of veins in nearly all mines, by frequent breaks in the deposits, by great masses of subterranean water in the basin of Valenciennes, and, until 1835 or even 1840, by the small scale of operations of all French companies except the Anzin This made mining difficult as soon as the veins near the surface had become exhausted, it was fortunate that the French had excellent schools, which trained their mining engineers well Finally, the cost and the difficulty of mining in France were increased by the ease with which the coal was broken up or pulverised It has been estimated that 75 per cent of English coal was mined in large pieces, and only 45 per cent of French coal [2] This meant that French coal was more difficult to sell and was much harder to ship for long distances without considerable loss It helps to explain also the frequent complaints of bad sorting of coal, which were made even against the great company of Anzin

The slow growth in the demand combined with the difficulties of mining helps to explain also the great delays in the full exploration of the basins Where strip mining was possible, as it still was at the beginning of this period in most French basins, no exploration seemed necessary and equipment could be of the simplest In the basin of Valenciennes, however, good equipment was required at a very early date, and it is natural to find that the Anzin company, which is said to have mined a quarter of all the coal produced in France from 1815 to 1848, and which certainly was the most important mining company, was the leader in improving pumps and extracting machines The mines of central or southern France were usually much less

[2] Burat, Amédée, *Le Matériel des houillères en France et en Belgique*, p 7

progressive, sometimes because the equipment really was not needed and sometimes because there were too many small companies, each with inadequate resources and all eager to compete rather than to coöperate Toward the end of our period many of the local differences in equipment were removed and many of the mines of the center and the south were as well equipped as those of the north, but in the Loire basin, at least, this did not happen until most of the small companies had also been removed

In nearly every basin in France exploration was pushed very slowly indeed until after the depression of 1827–32, then it increased with ever greater intensity until the Revolution of 1848 It is only after 1832, therefore, that much progress was made in organizing large mining companies capable of installing really good equipment and of thinking beyond immediate profits to the greater riches obtainable by scientific study of the full extent and resources of each basin The rate of progress of coal mining in France was thus closely connected with the rate of growth of business and industry in general and with that of the Industrial Revolution

A closer study of the cost of carrying coal shows that transportation was the most serious problem of all and served more than any other factor to keep up the price and restrict the consumption At the beginning of the period 1815–48 most of the coal was consumed locally, and manufacturing centers or large cities that were not near coal mines used it very little From the point of view of the coal merchant, France was divided into noncompeting regions by the expense and slowness of transportation And a few notable exceptions should not blind us to the fact that this viewpoint was substantially correct No coal basin could then play a part on the national stage unless it was virtually on the banks of a waterway or connected with one by a railroad We must, therefore, admit that, although French writers describe a great many coal basins in France, only about three were of any real importance in the industrial development of the country between 1815 and 1848 That there were few markets available for most coal mines and that, in general, little competition was possible were powerful deterrents to the growth in size of mining companies and to the enlargement of their operations to the point where the best methods and equipment could be used

The three basins that had a really vital rôle in the industrial

development of France as a whole were the Loire, Valenciennes, or the Nord, and Blanzy, or the basin of Saône-et-Loire, which includes the Creusot The Loire was the most productive throughout the period 1815–48, and, as we have seen, much of its coal was good for smelting and forging It was, therefore, the most important basin qualitatively as well as quantitatively Yet its situation raised difficult problems in an age of waterways The average price of coal from the Loire basin was frs 6 80 per ton at the mine and frs 19 40, on the average, at the place of consumption,[3] so that two thirds of the amount paid by the consumer was for transportation Even so, the coal was in such demand that it traveled farther than that of any other basin in France

The basin of Valenciennes had deep shafts and subterranean lakes that made the extraction of coal expensive, but it was well placed in northern France, where industry was developed far more than in central or southern France and where there were more important cities It was within reach of Normandy and Picardy, both of which had many large textile centers, as had the departments of Nord and Pas-de-Calais, and it was little more than half as far from Paris as was the basin of the Loire The rivers and canals of northern France were better and had fewer locks than those of central France, in addition, more was done to improve them between 1815 and 1847 The modernization of the canal of St Quentin in 1828 and the canalization of the lower Oise in 1835 were of decisive importance Such improvements in transportation were almost wholly responsible for the decrease in the price of coal at Paris between 1835 and 1851 from frs 37 per ton to frs 25[4]

It is interesting to recall also that the average barge in northern France or Belgium carried twice as much as the barge of central France because the waterways were deeper and wider The part of the price paid for transportation by the consumer of the coal of the basin of Valenciennes was only 34 per cent,[5] the lowest of any French basin that shipped coal to distant centers This was only half the relative cost of transportation of coal from the Loire basin The advantage of the basin of Valenciennes in facility of transportation

[3] *Journal de l'industriel et du capitaliste*, Vol 9 (August, 1840) Based on *Compte rendu des ingénieurs des mines pour l'année 1839*

[4] Burat: *Le Commerce des houilles en France*, p 28

[5] *Journal de l'industriel et du capitaliste*, as cited in note 3

and in favorable location with regard to important markets resulted in a steady growth of its influence in Paris Its sales there increased rapidly after 1830, whereas those of coal from the Loire remained stationary, in fact, its chief rival in the French capital came to be Mons rather than St Étienne

The cost of transportation, as has been said, was the most important factor in determining the price of coal to the consumer In many instances under the Restoration it raised the price to eight or ten times what it was at the mine, and in many others it prevented the use of coal altogether This cost decreased markedly under the July Monarchy, chiefly through the improvement of highways and the construction of local railroads, such as those serving the mines of the Loire and Épinac The Nord was the only main line completed before 1848 that could have had any appreciable effect on the coal industry The conclusion seems justified that often the price at the place of consumption shrank from eight or ten times the price at the mine to double that price, and that relatively few towns in France in 1848 were unable to obtain coal at all

The tariff did not have an important influence on the price of coal if we consider France as a whole The only powerful coal-mining company capable of exerting great political influence was Anzin, and it received ample protection under the Act of 1816 The mining companies of the Loire basin wanted even more protection than this Act provided, as did Anzin, but they were not united and were not really threatened by coal from abroad Their actual enemy was the high cost of transportation on French waterways, for their most desirable markets were not the ports along the Atlantic coast or the Mediterranean, in which they could not compete with English coal under any save a prohibitive tariff, but Paris and other industrial and commercial centers where they met coal from other French basins, or from Mons, which did not come in quantities large enough or at prices low enough to restrict the production of the basin of Valenciennes These facts were brought out at the *enquête* of 1832, called by the government in reply to repeated demands from the northern manufacturers Though the witnesses for the Anzin company were able to show that the tariff was partly responsible for the very high prices it paid for pumps and other mining equipment, the firm failed to prove that the prosperity of its mines was ever endangered by foreign competition, whether Belgian or English, and

its opponents were able to demonstrate that the prices and profits of Anzin were high

It was inevitable that disputes should arise regarding the conflicting rights of owners of the soil and of exploiters of the mineral wealth, which was usually some distance below the surface Further disputes arose when concessions were granted, since these had to be authorized by the government or its local representative, had to specify the rental to be paid to the owner of the soil if he were not also the exploiter of the mine, and had to fix the boundaries of each concession It is quite clear that under the Restoration the government favored the landowners, upon whose support it depended and of whom, in great part, it was composed, and it is also clear that the larger the landowner the more he was favored There is no clear evidence, however, of any well-defined governmental policy regarding manufacturing or commerce, because France was then overwhelmingly agricultural We may question whether, if the government had wished to promote large enterprises, they could have been soundly capitalized under the Restoration Most of the nation distrusted not only large enterprises, but all business, preferring to hoard its money or invest it in real estate or government securities We know that large companies were few, and it is probable that pressure by the government, had it been exerted, could not have increased their number appreciably

Under the First Empire the legal aspects of coal mining raised serious questions in the basin of St Étienne and, to a lesser extent, in that of Rive-de-Gier, which was the lower part of the same basin of the Loire But, as we have seen, the economic aspects also were difficult and confusing In the district of St Étienne there was at first much strip mining at very low cost, and there were many small veins reaching the surface The problem of the rights of landowners was, therefore, serious There appear to have been many landowners involved and also many exploiters, some of whom had evidently begun operations without the consent of those who owned the soil Under the Restoration, the government gave full ownership of mines to the large landowners, but dispossessed small ones, after compensation, and turned their mines over to the exploiters [6] The im-

[6] Burat, *De la houille*, p 414, Anon, "Notice sur les mines de houille de l'arrondissement de St Étienne," *Journal de l'industriel et du capitaliste*, 4 (1838) 184; Clément, Ambroise, "De la concentration des entreprises in-

portant factors in the situation at St Étienne were thus the character of the coal deposits and the administrative practices of the government officials involved The law was interpreted, as the government desired, to sustain the big landowners, but the method of coal mining was not changed under the Restoration except through the beneficent influence of the École des Mines at St Étienne, which helped the coal industry more than all the codes of Napoleon [7]

With the advent of the July Monarchy in 1830 and the end in 1832 of the depression of 1827 the development of coal mining in France became much more rapid Other causes, not always mentioned, were probably of even greater importance, namely first, the ever-increasing expansion of the iron industry, which now created a demand for coal so great that, as we shall see, the better coal-mining companies went on growing throughout the next depression from 1837 to 1842, and, secondly, the virtual end of strip mining with the exhaustion of the veins on the surface, so that hereafter shafts had to be sunk in almost all mines, better equipment had to be supplied, and capital had to be found to make possible exploitation on a more costly but more permanent basis

Under the new circumstances it was obviously necessary to end the situation in the Loire basin, where a great number of small exploiters were fighting each other in both the markets and the courts At Rive-de-Gier, where there were relatively few concessions because the shafts were already deep, the hatred between the companies was so great that they would not coöperate to fight floods, and the government was obliged to intervene to save the mines We have here, therefore, a change in governmental policy, reflected to some extent in legislation, as in the Acts of 1837 and 1838,[8] but still more, undoubtedly, in the administrative measures of local officials Simultaneously came a marked change in the attitude of the financiers and the public toward investment in coal mines Economic forces of considerable strength were working toward integration in coal mining in France In the Loire basin a veritable trust was organised through a series of purchases and combinations that extended from

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dustrielles et spécialement de la réunion des concessions houillères du bassin de la Loire," *Journal des économistes*, 13 (March, 1846) 337–355, especially p 344, Gras, Louis Joseph, *Histoire économique générale des mines de la Loire*, I 254

[7] See note 6

[8] *Journal des chemins de fer*, August 21, 1847, p 653, and August 28, 1847, p 669

1837 to 1845, when there emerged the powerful Compagnie générale des mines de la Loire, which controlled a majority of the mines in the entire basin (including all the best shafts) and at least two thirds of the production of coal It also acquired control of the Canal of Givors and of the railroad from St Étienne to Lyons There is reason to believe that the government approved the formation of this trust — if it did not actually encourage it — even though it did not give it legal authorization as a joint stock company with limited liability

The Compagnie générale des mines de la Loire was organized with a capital of frs 64,000,000, in shares of frs 1,000 each, and this was expected shortly to be increased to frs 100,000,000 [9] Although protests against it were made to the government by the cities of Lyons and St Étienne and by many interests which felt aggrieved, possibly because they had not been taken into the trust, there is every reason to believe that much more important interests supported the combination We know that during the formation of the trust, from 1837 through 1845, capitalists at Lyons were working for it in the basin of Rive-de-Gier, while others, chiefly from Paris, were organizing or buying up the many small concessions in the basin of St Étienne This division of financiers was to be expected, for the lower part of the Loire basin was a natural source of supply for Lyons, while the upper part, being nearer the Loire, could more readily send its coal down that stream in the direction of the national capital

In the north of France we have another example of integration in coal mining in the Anzin company This was organized first between 1717 and 1720, but failed Then it passed into other hands and went through a series of lawsuits, in the course of which the interests of two of the great landowners involved, the Prince de Croy and the Marquis de Cernay, were sustained by the courts In 1757 there was drawn up the partnership agreement which governed the company for many years Its most notable feature was the council of six regents, which held all the power, was not obliged to call meetings of the shareholders, and was self-perpetuating. About the beginning of the nineteenth century the Anzin company came under the control of the Périer family, including Scipio, the banker, who died in 1821, and his brother Casimir, who died in 1832, as president

[9] Clément, "Nouvelles Observations sur le monopole des houilles de la Loire," *Journal des économistes*, 16 (Dec., 1846) 21–22, Gras, *op cit*, I 296–298, 303

of the company and prime minister of France[10] He was succeeded by Adolphe Thiers, much better known as a minister of Louis Philippe and as the first head of the Third Republic

No organization in France seems to have been so successful as Anzin in keeping its archives inviolate and its business affairs from the knowledge of the public, but few have been directed throughout their history with more ability or more continued success From the beginning of the nineteenth century, if not earlier, land was bought for possible mining in the future and funds were set aside for a financial reserve that enabled the Anzin firm to emerge from each depression unscathed

The Anzin company was, furthermore, a leader in developing the use of steam for running both pumps and extracting machines and set a valuable example in promoting better methods of exploitation, but it seems also to have been energetic in keeping wages down and prices up, and was evidently strong enough to follow its own policy unhampered, for it has been described several times as quite indifferent to the needs or wishes of consumers In the period after 1832, when the development of coal mining increased so rapidly, the Anzin company was one of the most active in underselling and buying up weak competitors But it was foremost in the search for new and richer veins of coal, by means of whose acquisition it began in 1832 the development of what proved to be the most valuable of all its concessions, that of Denain, which, toward 1848, was becoming also a metallurgical center of great importance The growth of the Anzin company is reflected in the value of its shares Under the Restoration each share increased in value from frs 22,000 to frs 90,000, in 1836 a share was worth frs 160,000; and in 1843, frs 200,000[11]

Another company deserving of mention is that of Blanzy, which seems to have developed on a small scale and in complete obscurity in the basin of Saône-et-Loire until 1834, when reorganization with new capital, followed by another reorganization in 1838, set it firmly on the road to prosperity Under the Law of 1838 the Blanzy company was able to combine five different concessions, and the

[10] *Bulletin de la Société pour l'encouragement de l'industrie nationale*, 1821, No. 202 118, Turgan, Julien François, *Les Grandes Usines*, XV 3

[11] Cahen, Léon, "L'Enrichissement de la France sous la Restauration," *Revue d'histoire moderne*, 1930, p 185

government exempted it from the statutory requirement of operating them all simultaneously In spite of these improvements the Blanzy company remained puny by comparison with the great companies of Anzin and the Loire, but it seems to have had in its management men interested in promoting the selling of coal on sound commercial principles, and it may have been unique among the smaller companies in disposing of its coal, not at the nearest river port, but through agencies at Chalons-sur-Saône, with warehouses at Lyons and Mulhouse and, shortly after 1848, with another agency at Paris Professor Amédée Burat, the eminent geologist of the middle of the nineteenth century, tells us, also, that the Blanzy company was able to double its circulating capital, presumably through the reorganizations of 1834 and 1838, and that it was the only coal-mining company besides Anzin that met all its financial obligations in the Revolutionary year of 1848

During the period from 1815 to 1848 the coal-mining industry of France passed through the pioneer stage At the beginning, the greatest basin of all, the Pas-de-Calais, had not been discovered and virtually none of the other basins had been fully explored Strip mining was prevalent, and coal was sorted carelessly and frequently crumbled so much that it depreciated in value Anzin was almost the only company strongly organized, with an adequate supply of capital and reasonably good equipment Transportation was so inadequate that most mines were wholly dependent on local markets, and many industrial and commercial centers were unable to obtain coal at all The majority of the mines were occupied with cutthroat competition and lawsuits, and the demand for coal was so small that even the government seems hardly to have realized the importance of the industry

In 1848 the exploration of the basin of Pas-de-Calais was beginning, and the full resources of most other basins were known Nearly all mines had shafts and adequate equipment Cutthroat competition had been ended through governmental pressure and financial reorganisation with considerable supplies of capital The more important mines had been connected with waterways by short railroads, the waterways and even the highways having been improved until nearly all important centers were able to obtain coal at reasonable cost Finally, the immense growth of the iron industry had created an almost indefinite demand for coal, and the beginning

of the construction of a network of main railroad lines was providing the basis for unlimited expansion of coal mining in the future

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BRITISH MOTIVES FOR EXPANSION IN 1763. TERRITORY, COMMERCE, OR SECURITY?

FRED J ERICSON

THE territorial acquisitions which Britain secured in the Peace of Paris in 1763 climaxed a successful phase of her colonial expansion But why did she choose undeveloped North American regions instead of the rich West Indian sugar islands? Many leading American historians have accepted the contention of George Louis Beer[1] that this choice represented a "turning-point in British colonial policy," from emphasis on colonies as sources of supplies to recognition of their potentialities as markets Some believe that the opposition of the entrenched British West Indian planters to new islands producing sugar decided the issue[2] Others think that the most important consideration was security for the British colonists in North America[3] The question is of some significance because of its connection with the whole problem of the nature of British colonial policy in the 1760's

Beer's commonly accepted theory undoubtedly represents an aspect of the truth, for there was a pamphlet conflict in the early 1760's over the ideal nature of the British empire Any one explanation, however, tends to oversimplify a very complex group of motives[4] The controversy involved much more than conflicting opinions as to territorial and commercial values At least four factors were influential. the desire for security, the possibility of economic ad-

[1] *British Colonial Policy, 1754–1765* (New York, 1907), p 139, see also Alvord, C W, *The Mississippi Valley in British Politics* (Cleveland, 1916), I 49

[2] Pitman, F W, *The Development of the British West Indies* (New Haven, 1917), pp 346, 351

[3] Namier, L B, *England in the Age of the American Revolution* (London, 1930), I 321

[4] Such writers as Beer and Alvord do not ignore the security issue and the other factors, but they give them so little attention that the impression results that they were subordinate features of policy

vantages, the importance of territory per se, and political and diplomatic pressures and propaganda In the single matter of economic advantage the West Indies probably had clear preference in the British mind Advocates of the islands also relied upon the British prejudice against too extensive an empire and the fear of colonial independence But the combination of other considerations — some of slighter importance if taken alone — outweighed these arguments The far greater value of the North American continent as to vital security, its manifest possibilities for future expansion, and its commercial utility, though less immediate, combined to make its case the stronger one

There is no lack of contemporary intimations that Britons were obsessed by the "magnificent" delusion of territorial aggrandizement and that the exponents of North American expansion had suggested a "system which if no[t] contrary to our national benefit, is at least contrary to all our former Ideas of it " [5] Indeed, most attributes of what the modern world labels imperialism were present in the justifications offered for colonial growth, not even the idea of the "white man's burden" was entirely absent [6] The aspect of this "territorialism" which has led some historians to contrast it with mercantilism was its insistence on provision for future growth and ultimate profit Benjamin Franklin, an enthusiast for British expansion,[7] appealed to commercial appetites in urging the retention of Canada Writing to John Hughes on January 7, 1760, he said that the security argument was the more effective, but continued. "To this I add, that the Colonies would thrive and increase in a much greater Degree, and that a vast additional Demand would arise for British Manufactures, to supply so great an Extent of Indian Country, etc " [8] In the so-called "Canada pamphlet"

[5] [Burke, William,] *An Examination of the Commercial Principles of the Late Negotiation between Great Britain and France in MDCCLXI* (London, 1762), pp 6–7, 14

[6] The London and Westminster Dissenting ministers addressed the King on June 15, 1763, they praised the tangible values of the new territories and added that they opened the "way for diffusing freedom and science, political order and Christian knowledge, through those extensive regions, which are now sunk in superstition and barbarism, and for imparting, even to the most uncultivated of our species, the happiness of Britons" *Newport Mercury*, October 6, 1763

[7] See Crane, V W, *Benjamin Franklin, Englishman and American* (Baltimore, 1936), *passim*

[8] *The Writings of Benjamin Franklin*, ed A H Smyth (New York, 1906), IV · 8

Franklin and his British friend Dr Richard Jackson developed this same theme, a note of welcome was sounded for continental colonies in the observation that "a man must know very little of the trade of the world, who does not know, that the greater part of it is carried on between countries whose climates differ very little "[9]

Less important writers than Franklin echoed these contentions An author of 1762 approved of "this immense Increase of a growing Empire, which already raises us to a Level with the most Mighty in *Europe*, and besides increasing our Commerce, supplies, by an incredible Increase of People, that only Defect, which confined us, as a State, to the third or fourth Place in the Scale of *European* Powers "[10] Another pamphleteer admitted that the sugar islands had "eminently the Advantage in respect to immediate Interest," but thought that continental acquisitions had the "distinguished Preference in regard to durable Power and remoter Profit . " He found the source of British power in the "human Hive" of North America and not in "the sultry Tropics "[11]

There were some visions of early settlement of the newly acquired lands One author recommended two or three colonies on the Ohio and Mississippi, he believed that the "present colonies would soon branch out into those fertile countries, and would supply them with settlers without any further drain from the mother country "[12] In 1763 a pamphlet which extolled Bute, the retiring prime minister, employed the striking figure "seeds of infant nations" in referring to his reported plans to settle the new colonies[13]

Such theories of the future usefulness of colonies were in accord with the apologies for the peace in the parliamentary debates of 1762 Shelburne, for example, spoke of increased population and consequent employment for millions of Britons for "ages to come "[14] The debaters also used terms of the new dualism of colonial utility,

[9] *The Interest of Great Britain Considered, with Regard to Her Colonies, and the Acquisitions of Canada and Guadeloupe* (London, 1760), p 33

[10] *The Comparative Importance of Our Acquisitions from France in America* (London, 1762), pp 42 f

[11] *Reflections on the Terms of Peace* (London, 1763), pp 5, 30

[12] *Reflections on the Domestic Policy, Proper to Be Observed on the Conclusion of a Peace* (London, 1762), p 73

[13] *The Appeal of Reason to the People of England, on the Present State of Parties in the Nation* (London, 1763), p 21

[14] Temperley, H W V, in *The Cambridge History of the British Empire* (New York, 1929), I 505, citing the Shelburne Papers, CLXV.

territory and subjects being an objective, as well as the "mere advantages of traffic "[15]

Besides the idealistic justifications of expansion for future use exponents of North America cited more immediate considerations The continent was praised for its fur, fish, and timber and its real or imaginary silk, cotton, and grapes, as well as for its possibilities in the way of food and plantation crops[16] The immediate value of the sugar islands was deprecated in view of the lesser ultimate importance of their single commodity Finally, the fears that a greater America would mean a greater danger of independence were ridiculed Franklin's insistence that colonial expansion would mean increased dependence upon agriculture and the importation of British goods, and hence less danger of independence, is well known[17]

On the other hand, those who favored West Indian acquisitions, the somewhat more conservative group, often expressed a different theory of colonial values Both schools, however, appealed to much the same fundamental principle of a well-balanced empire The major difference was over which type of possession best satisfied mercantile qualifications

The advocates of small valuable accretions appealed to the old British fear of overexpansion, and at times forced the adherents of wider growth to accept the defensive and to seek to prove the moderation of their demands[18] The corollary of the distrust of territory per se was the belief that "Common Sense would dictate to us the Scheme of Acquisition where we wanted, not where we did not want "[19] Southern and West Indian colonies had been found conducive to a "perfect *Colony Trade*",[20] they were in a different climate, produced plantation staples, and could not set up domestic manufactures Such colonies and the mother country were

[15] *Parliamentary History*, XV 1272

[16] Shelburne Papers in the William L Clements Library, Ann Arbor, Michigan (hereafter referred to as "WLCL"), XLIX 365-396, Knox Papers (WLCL), IX fols 2-3

[17] *The Interest of Great Britain Considered, etc*, pp 24 ff

[18] An advocate in the early 1760's of vigorous British control for the colonies thus argued that with proper regulations the enlargement of the empire would "still be an addition to the National Strength " "A Short Discourse on the Present State of the Colonies in America with Respect to the Interest of Great Britain" (in the Ayer Collection, Newberry Library, Chicago, Illinois, hereafter referred to as NL), [written before June, 1763], p 10

[19] [Burke,] *An Examination of the Commercial Principles, etc*, p 36

[20] *Ibid*, p 24

said to be "mutually formed for each other"[21] Sugar was emphasized as a commodity of special importance in British empire economy, which would have an even greater value when Britain should regain the world market It was shown that Britain's sugar islands were suffering in competition with the newer and less exhausted French ones and that the British planters were already leaving for the newly conquered islands[22] Upon the whole, it was concluded that sugar and other West Indian products made up "the most proper food for the commerce of Britain "[23]

Another contention was that the West Indies were responsible for such value as the North American colonies possessed for Britain and that therefore they should be as nearly proportioned to each other as possible[24] There was now an opportunity to restore the "equilibrium" between the two types of possessions,[25] this would remove the "colour of necessity" for the old illicit trade between North America and the French islands[26] It was also urged that if security were a consideration attention be given to buttressing the security of the West Indies, where the French had the "real Superiority"[27] And, in answer to the exponents of continental acquisitions, it was asserted that the wastes, deserts, and inaccessible regions of North America would be valueless to the empire Should they become settled, they would necessarily be economically independent and thence, in time, politically independent also[28]

But would these thinkers enlarge British possessions in one favored area only and leave the North American colonies throttled? By no

[21] [Burke,] *Remarks on the Letter Address'd to Two Great Men In a Letter to the Author of That Piece* (London, [1760]), pp 47 f

[22] Summarized from the pamphlets by William Burke and the "Copy of a Letter from a Gentleman in Guadaloupe to His Friend in London August, 1760" in [Almon, John,] *Anecdotes of the Life of the Right Honourable William Pitt, Earl of Chatham* (London, 1792), IV 154–160.

[23] [Maudit, Israel,] *Occasional Thoughts on the Present German War* (London, 1761), p 3

[24] "Copy of a Letter from a Gentleman in Guadaloupe," in Almon, *op cit*, p 157

[25] *A Letter to a Great M r, on the Prospect of a Peace* (London, 1761), pp 81 f

[26] *Candid and Impartial Considerations on the Nature of the Sugar Trade* (London, 1763), p 221

[27] [Burke,] *Remarks on the Letter Address'd to Two Great Men, etc*, p 28

[28] The most interesting and specific of many prophecies of American independence was contained in the pamphlet *The Interest of Great Britain in the Approaching Congress Considered* . (London, 1761), pp 36–44

means, they answered Canada was not part of Britain's war aims and could well be given up William Burke said that Britain should accept her real boundaries as regards Canada, fortify the passes, and insist upon the Ohio country and possibly the lands to the Mississippi This would give ample room for expansion and for the fur trade and provide Britain with "every thing either of Strength or Value in *North America*"[29] In the light of the part expansion may have played in causing the paramount event of 1776 this "rational" program now reads like the soundest policy which Britain could have adopted She followed the advice of the spokesmen for expansion, however, and the empire became, as William L Grant says, "long on the products of farm and forest, and short on sugar"[30]

The undoubted existence of such mutually opposed arguments as have been recited would seem to indicate the separation of British opinion into two well-defined schools of thought But there are considerations which qualify such a conclusion For one thing, there was a great deal of ignorance about the American conquests If the King could get the Mississippi confused with the Ganges boundary, if Newcastle could refrain from correcting him — not from deference, but because, as he said, he was "far from knowing exactly the state and limits of those countries"[31] — the ignorance of others is not surprising So, the less desirable such a territory as Florida appeared to be, the more profuse became the cotton, silk, wine, indigo, hemp, and flax with which the desert would soon blossom forth Perhaps more significant is the fact that most of the leaders of public opinion changed from side to side on the issue of the policy of expansion[32] Furthermore, neither of the positions as to commerce or territory was as important as another consideration upon which statesmen maintained a greater degree of consistency. This was the factor of security.

[29] *An Examination of the Commercial Principles, etc*, p 71

[30] "Canada versus Guadeloupe, an Episode of the Seven Years' War," *American Historical Review*, 17 (1911–12) 742

[31] Yorke, P C, *The Life and Correspondence of Philip Yorke, Earl of Hardwicke* (Cambridge, 1913), III 414, citing Newcastle Papers, 257, fol 145, Newcastle's account of a talk with the King For stories of the self-confessed ignorance of ministers and the Board of Trade see Knox Papers (WLCL), X fol. 35, Shelburne Papers (WLCL), XLIX. 350

[32] For examples of prominent statesmen taking a position opposite their usual one see *Parliamentary History*, XV 1265 f. (Pitt); *Correspondence of John, Fourth Duke of Bedford*, ed Lord John Russell (London, 1846), III 32 (Bute)

The wish for security has not been entirely overlooked by historians, but it has been relegated by most of them to a subordinate position Pamphlets and other sources alike show that it was usually given distinct, and prior, consideration by writers of both schools and that most statesmen treated it as the vital factor in the final decision

Two major types of security were desired colonial security against French and Indian troubles and British security against the necessity of diverting forces from European fronts to extensive secondary battle areas in the New World These desires were not caused by imaginary dangers. Despite its victory, Britain could well be alarmed at its paradoxical position in world affairs Two old enemies, France and Spain, had recently proved their unity by common action One old friend, Austria, was now a defeated enemy, and a recent ally, Prussia, was a much disgruntled neighbor, thanks to the futile diplomacy of Bute British isolation during the American Revolution was soon to testify to the soundness of the desire for security against repetitions of costly wars along a colonial frontier

The wish for the conquest and retention of Canada arose because of the conviction that such an accession would procure safety from French and Indian attacks [33] The New England preachers who exulted over victories in Canada almost invariably placed the prospect of peace in the "first place" [34] among the advantages to be gained by its conquest The same point of view was expressed by British and American pamphleteers who favored North American acquisitions

One of the first British pamphlets in the war of ideas on the coming peace settlement was that of John Douglas, Bishop of Salisbury, which first appeared in 1759 Why did he insist on the North American conquests being retained as the "*sine qua non* of the Peace"? [35] His whole argument was based on the security factor,

[33] In 1756 Governor Shirley wrote Henry Fox that, in the light of experience, "the least expensive, most effectual and most practicable Measure for cutting Short these Mischiefs [from French and Indians] would be to take Canada itself, *and keep it*" "Letter to Henry Fox, January 24, 1756" (in the Ayer Collection, NL)

[34] Mayhew, Jonathan, *Two Discourses Delivered October 25th 1759* (Boston, 1759), p 43 See also Foxcraft, Thomas, *A Sermon Preached in the Old Church in Boston October 9, 1760* (Boston, 1760), p 30

[35] [Douglas, John,] *A Letter Addressed to Two Great Men, on the Prospect of Peace, and on the Terms Necessary to Be Insisted upon in the Negotiation* (2d issue of 1st ed ; London, 1760), pp 33 f

to the specific exclusion of economic advantages from Canada itself Britain must do more than hold the places upon which the French had encroached since Utrecht, else the colonists would say "you have done *Nothing* In a Word, you must keep Canada, otherwise you lay the Foundation of another War"[36] But as to the value of Canada, its climate and poor trade had made the French "tired" of it, that such a territory — "not worth" the asking to the French — was of worth to Britain was based, for Douglas, simply on the necessity of avoiding the "Repetition of former Encroachments"[37] To be sure, Douglas wrote warmly of the "infinite Consequence" of America and its expanding trade to Britain, but this referred to the colonial areas which were now to be safeguarded[38]

The pamphlet best known for its advocacy of the acquirement of Canada is the "Canada pamphlet" of Franklin and Jackson The theory that continental acquisitions would provide for expansion of population, settlement, and British trade is frequently cited as its principal contribution It should not be overlooked, however, that the first major element in the pamphlet was a discussion of "security" and that this was followed by the economic argument and the refutation of the fears of colonial independence[39] Statement of the types of security needed — against French dispossession of the colonies, against the Indians, and against the expenses of future wars — is followed by the conclusion " all the kinds of security we have mention'd are obtain'd by subduing and retaining *Canada*"[40]

Many of the other pamphlets on the subject also stressed this aspect One which Alvord believes may have been written from William Pitt's notes by his undersecretary Wood[41] took no issue with those who were "so thankful" for the capture of Montreal, but said that if Montreal were judged by what it would produce it would be a "trifling acquisition"[42] A writer who admitted that there was "no doubt but Guadaloupe is of more Consequence in a commercial View than Canada" insisted that Britain should give up any other

[36] [Douglas, John,] *op cit*, pp 29 f
[37] *Ibid.*, pp 30 f [38] *Ibid*, p 34
[39] *The Interest of Great Britain Considered, etc*, pp 4–15
[40] *Ibid*, p 14
[41] Alvord, *op cit.*, II 259
[42] *Reasons in Support of the War in Germany, in Answer to Considerations on the Present German War* (London, 1761), p 45

conquest rather than "part with one single foot of Canada." He explained

In my Reasons for it I differ, however, from those who affect to esteem it important, on account either of its Trade, the Number of Inhabitants, or the Fertility of its Soil, the principal Objection that appears to me, against giving up any Part of Canada is the Danger we thereby run of giving Occasion, in a few Years, for another War [43]

The importance of the security objective is also seen in a pamphlet, possibly by Israel Maudit, which criticized the conduct of the war and observed " the general opinion, and I believe a very just one, was, that this war was in effect to put an end to all war, by a general eradication of the French power in America " [44]

Those who proposed Eastern Louisiana as a desirable area to be insisted upon in addition to or in preference to Canada linked the security factor with the contention that Louisiana was the more valuable field for expansion One writer claimed that it was "forty times" as useful as Canada, unless the Mississippi were the new boundary, he contended, Britain would lose the "end" of the war, "*the security of our colonies*" [45] Another pamphleteer said that Louisiana was far more necessary than Canada both for its value and for colonial security, by its retention Britain would get "the most desirable security, without being incumbered with the cold, barren, uncomfortable, and uninviting country of Canada " [46]

Proposals for early settlements in the newly acquired territories were frequently associated with the security motive As early as 1759 a pamphlet addressed to Pitt advised the establishment of forts

[43] *A Letter to the People of England, on the Necessity of Putting an Immediate End to the War* (London, 1760), p 47 For the same opinion see *Considerations on the Approaching Peace* (London, 1762), pp 20–24

[44] *The Plain Reasoner or, Farther Considerations on the German War* (London, 1761), p 21 Another writer thought that Canada was useful to France only for the means to attack the British, and therefore, he said, "in this View, altho' it should yield no more than the pitiful Import which the Author [William Burke] brings to its Account the Purchase was well made, at the Expence of much Blood and immense Treasure " *The Comparative Importance of Our Acquisitions, etc*, p 25 See also *An Answer to the Letter to Two Great Men* (London, 1760), p 15

[45] *Sentiments Relating to the Late Negotiation* (London, 1761), pp 4 f, 9

[46] *A Letter to a Great M r, etc*, p 73 Again it was proposed to retain the Mississippi boundary and "intirely cut off all occasion of dispute in America." *The Proper Object of the Present War with France and Spain Considered* (London, 1762), p 50 See also *Reflections on the Domestic Policy, etc*, p 71

and settlements between the mountains and the mouth of the Ohio, the settlements, it was said, "might be gradually carried on between the Mississippi and the Alligany mountains, backwards and forwards at the same time"[47] In 1761 an advocate of the Louisiana acquisition said that by settling the British side of the Mississippi it could be made impossible for the French to "*encroach* without openly *invading*"[48] And a pamphlet of 1763 combined security and colonization in its title *The Expediency of Securing Our American Colonies by Settling the Country Adjoining the River Mississippi, and the Country upon the Ohio, Considered*[49]

Those who opposed the emphasis placed upon North American accessions testified that the argument for security was the chief one to be refuted William Burke said in 1762 that he did not know a pro-Canada writer who "has made a single direct assertion in Favour of the commercial Advantages of *Canada*" Rather such writers had told of the economic values of the American colonies and had skillfully left it to the reader to conclude that North America and Canada were synonymous[50] Burke challenged anyone to prove "that our Colonies could not have had a rational Security, without the Possession of all *Canada*"[51] His own proposal for expansion in the Ohio country was said to provide for "at least double" the former degree of security[52] When he took up the consideration of the "causes" for overlooking the advantages of the West Indies, Burke gave many pages to the security aspect He remarked that some who had been enemies of the American colonies had become great advocates for their security, and continued

> This very groundless Opinion [of the need for colonial security] was the true Source of our Neglect in the late Negotiation, of such real, commercial Advantages, as might augment the Resources of *Great Britain* And from hence proceeded that utter Oblivion of all former Maxims of our Policy, whilst, under the Name of Security, we sought with Eagerness extensive and unprofitable Empire, and rejected moderate but lucrative Acquisition[53]

It will thus be seen that to the evidence for the weight of the security issue which comes from the advocates of wide continental expansion is added the confirmations of their opponents The latter

[47] *A Letter to the Right Honourable William Pitt, Esq, from an Officer at Fort Frontenac* (London, 1759), p 23

[48] *Sentiments Relating to the Late Negotiation*, p 10 [49] Edinburgh, 1763

[50] *An Examination of the Commercial Principles, etc*, pp 71 f

[51] *Ibid.*, p 70 [52] *Ibid*, p 86 [53] *Ibid*, p 69

admitted the importance of the matter in the British mind, but sought to show that it was exaggerated into an unwise demand for all the available conquests in North America Even more significant proof that security was the decisive factor in British policy is furnished by the indications of the motives of the statesmen who made the final choice

At the time that John Douglas' initial pamphlet was creating discussion in London Franklin was in England Writing to John Hughes on January 7, 1760, he told how some "among our Great Men begin already to prepare the Minds of People" to give up Canada The arguments against Canada which he recited were those which were to become threadbare in the next three years But that Franklin did not await the Stamp Act to show his aptitude for persuasion of British opinion is shown by his next remarks

> These Notions I am every day and every where combating, and I think not without Success The Event God only knows The Argument that seems to have principal Weight is, that, in Case of another War, if we keep Possession of Canada, the Nation will save two or three Millions a Year, now spent in defending the American Colonies, and be so much the stronger in Europe, by the Addition of the Troops now employ'd on that Side of the Water To this I add [the argument of an increasing market in America for British goods] with many other Topics, which I urge occasionally, according to the Company I happen into, or the Persons I address And on the whole, I flatter myself that my being here at this time may be of some service to the general Interest of America [54]

British statesmen frequently used reasoning similar to that of Franklin Pitt often expressed his determination that the French must be "totally removed" from the North American continent [55] Just before the rupture with Spain the Earl of Bristol replied to Spanish upbraiding regarding British conquests by saying that his country was concerned only in freeing the American colonies from French encroachments and preventing "a Repetition of such Chicanes from the *French*, as has caused the Beginning of those Disturbances " [56] Bute, who inherited the Pitt pro-Canada program, told Bedford on May 1, 1762, why he was insisting on the Mississippi boundary and sacrificing the principal sugar islands to "secure in perpetuity our northern conquests from all future chicane " [57] Most

[54] *The Writings of Benjamin Franklin*, IV 7 f.

[55] Hall, Hubert, "Chatham's Colonial Policy," *American Historical Review*, 5 (1899–1900) 670 ff ; *London Chronicle*, January 25–27, 1763

[56] *Papers Relative to the Rupture with Spain* . . (London, 1762), p 29

[57] Bute to Bedford, May 1, 1762, *Correspondence of* . *Bedford*, III 76

interesting was the position taken by the indecisive Newcastle He related that he had informed Pitt in December, 1760, that "Some were for retaining all Canada, as our Northern Colonies would never be quiet without it," while others thought Guadeloupe "in reality more advantageous for us" [58] One of Newcastle's advisers, who was using the same reasoning upon him, was the merchant Sir William Baker Namier quotes from the Newcastle "Memorandums for the King" of October 14, 1760

Alderman Baker's reasoning The keeping of Canada the most necessary for preserving the peace, which cannot be done, whilst Canada and those parts are divided between two rival powers, England and France, as the Indians will always be stirr'd up one against the other The keeping the others [sugar islands] might be more beneficial in point of trade, but the other for the preservation of peace [59]

On the eve of the peace debates of 1762 Newcastle wrote Hardwicke "I still adhere to my old opinion that the evacuation of all Canada, possibly in the manner now done, was the first object, we ought to have in view, as that carries security with it for the future" He criticized the restitution of the sugar islands to France, however, for that meant that there was to be no adequate return for the year of victorious warfare since 1761 [60] Hardwicke, who was willing to consider restoring "almost any thing" except the fisheries in order to keep the Caribbean islands, admitted that the prevention of future French encroachments was the "most material argument" for Canada [61]

It was for such reasons as those given by Newcastle that the opponents of the peace in 1762 did not take the line laid down for them by the territory-versus-commerce paper warfare Instead of denouncing the American conquests and demanding their exchange for sugar islands they conceded the finality of the continental acquisitions and concentrated their attacks on the impotence of Bute's ministry in not securing something in the West Indies after a year of additional success The apologists for the peace placed due emphasis upon the security consideration The part of the debate

[58] Newcastle to Hardwicke, December 3, 1760, in Yorke, *op cit*, III 314, citing Newcastle Papers, 230, fol 268

[59] Namier, *op cit*, I . 318, citing Add MSS, 32913, fol 128

[60] Newcastle to Hardwicke, November 29, 1762, in Yorke, *op cit*, III · 437 f, citing Newcastle Papers, 260, fol. 196

[61] Namier, *op cit*, I 324 f, citing Add MSS, 32936, fols 310–311

which is frequently cited as evidence for the theory of a shift to territorial imperialism[62] was really secondary to the declaration that "the original object of the war was the security of our colonies upon the continent" and that restriction of the French was "therefore the most capital advantage we can obtain, and is worth purchasing by almost any concessions "[63]

The decisive priority given to the question of security — often in the very listing of arguments — by such men as Franklin, Pitt, Bute, Newcastle, by merchants like Baker, by the defenders of the peace in 1762, and by the pamphleteers seems convincing testimony that it was the issue which turned a losing policy into the winning one[64] As was so frequently said, the other conquests were of more value, but the continental territories were judged necessary for the safety of the existing possessions Once the decision was reached, of course, all possible arguments were brought forward to justify the territory gained It was customary, for example, to combine the major factors in some such phrase as "the complex Account of Advantage and Security,"[65] or to speak of the "great Advantages of Commerce and Security "[66]

Did the choice of 1760–63 represent a change from mercantile to territorial standards of empire? There was some shift in emphasis on established mercantilistic ideals Security was given first consideration, this, of necessity, involved preference for territory whose acquisition could best be justified from the economic standpoint because it provided markets for British products But some degree of colonial expansion, the desire to protect colonies already estab-

[62] See *supra*, pp 583–584.

[63] *Parliamentary History*, XV 1271 f

[64] Chesterfield wrote Newcastle, November 30, 1760 "I think we should keep Quebec and Canada as preventitives of future war, and for the rest scramble and negotiate as we can but Guadeloupe is a much more lucrative possession " Namier, *op cit*, I 321, citing Add MSS, 32915, fol 194 Lord Morton, also, advised Hardwicke, January 13, 1760, that North American possessions should be retained for considerations of peace although he did not expect them to be peopled in "ten centurys" Namier, *op cit.*, I 323, citing Add. MSS, 32924, fols 311–322 Thomas Hutchinson testified that Canada had been retained for the "security" of the colonies *The History of the Colony and Province of Massachusetts-Bay*, ed L S Mayo (Cambridge, Mass , 1936), III 254

[65] *An Address to the People of Great-Britain, on the Preliminaries of Peace* (London, 1763), p 8

[66] "A Letter from L[ord] Egremont to the Lords of Trade, on the Advantages to Be Derived from the Peace of 1763 Dated May 5, 1763," Shelburne Papers (WLCL), XLIX : 284.

lished at great expense, and the prevention of costly frontier wars, as well as a hope of greater markets for exports, do not seem inconsistent with mercantilistic principles That the former prime consideration of a staple product for each colony in a "perfect" empire[67] was subordinated to the urgent necessity for future safety is the most that can be said for the contention that there was a change of policy in 1763 Therefore, the view that the Peace of 1763 signified a deliberate change from an older to a newer theory of the value of colonies seems untenable Despite the emphasis on security, there was more continuity than innovation in the decision made But this is not to say that the new territorial expansion of 1763 did not have very significant effects on the trends of British policy from that time forward

The historians of that peace have been inclined to place too great emphasis upon one or another of the issues which have been discussed here Namier, for example, has been correct in calling attention to the importance of the security motive, but he has not given proper credit to other considerations It has been shown that there was a significant clash between territorial and commercial concepts of empire, and local self-interest and jealousy were also present The wish for security was nonetheless the factor which was so associated with the other elements involved that it was decisive in the British determination to acquire Canada and the West in 1763

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[67] "Thoughts concerning the Colonys [1765?]," Shelburne Papers (WLCL), XLVIII . 74

COLONEL GUY JOHNSON, SUPERINTENDENT GENERAL OF INDIAN AFFAIRS, 1774–82

HARLEY L. GIBB

THE subject of this sketch, Colonel Guy Johnson, held the important office under the British of Superintendent General of Indian Affairs for the Northern Department of North America during the American Revolution. Turn where you will to secondary sources, his is a most elusive character, yet the ghost of his authority stalked in the shadows of every Indian campfire during the Revolution. The names of his subordinates, Major John Butler, Captain Daniel Claus, Captain Alexander McKee, and others, are better known to the historian than his own. But the evidence does show that his career ended in a trial at Quebec under charges of misfeasance and malfeasance.[1]

Colonel Guy has been described as short and pursy, of stern countenance and haughty demeanor, his voice was harsh and hinted at his Irish extraction. In accordance with the fashion of the times, he wore his hair powdered. An engraving by Bartolozzi shows him in a military coat, a man of pleasing, even handsome, appearance, with an open countenance characterized by widely separated eyebrows. A full-length portrait by Benjamin West in the Mellon Collection in the National Art Gallery, Washington, gives much the same impression: a man in his late thirties or early forties, with very dark hair, intelligent eyes, and a face which, though sharper, is still pleasant.

One of the seven sons of John Johnson, a brother of Sir William Johnson, Colonel Guy was born in County Meath, Ireland, in 1740, he came to America and was serving in the Indian Department in the Mohawk Valley as early as 1756,[2] and subsequently took part

[1] Public Archives of Canada (hereafter cited as Can. Arch.), B, CVII 279–281, 297–299, 315–317.

[2] Can. Arch., Report for 1887, pp. 85–109, contains a calendar of Guy Johnson's letters for the years 1779–83. A letter of January 11, 1783, gives

in expeditions against the French throughout the Seven Years' War, a part of the time as secretary to Sir William He was with his uncle at the Battle of La Belle Famille, near Niagara, on July 29, 1759, where fifteen hundred Western Indians were crushed and where Sir William clinched his reputation as an outstanding Indian military strategist Later in this campaign Colonel Guy became a lieutenant in one of the independent New York companies and commanded a body of Rangers in the force which General Jeffrey Amherst conducted up the northern part of New York in the campaign of 1759–60 Entering Montreal with the army in September, 1760, he remained there for some time as Indian agent [3]

After the war he held the commissions of colonel and adjutant general in the New York militia and early in 1762 was appointed deputy superintendent for the Six Nations and the neighboring Indians under Sir William In this capacity he attended all the frequent Indian councils, served at times as secretary to the Superintendent, and, on occasion, acted for him during his absence After the conclusion of peace in 1763 Colonel Guy married Mary Johnson, Sir William's younger daughter, and established his residence at Guy Park Manor, the handsomest of four residences erected by Sir William, near Amsterdam, New York In 1762, just before his marriage, the scope of his duties had been enlarged, for at that time he was appointed deputy Indian agent by his father-in-law, with full power in the Northern Department, and was, besides, placed on half pay as a lieutenant in one of the New York companies [4] From then until the death of Sir William, on July 11, 1774, he carried the heavy burden of the details of the business of the Superintendent. In December, 1770, when Sir William declined reëlection as Master of the Free and Accepted Masons, St Patrick Lodge, No 4, Colonel Guy was elected master in his stead Besides being judge of common pleas in Tryon County, he was elected to the New York Assembly and served intermittently during the critical term 1773–77 [5] Sir William's oldest son, Sir John, two years Colonel Guy's junior, was

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an outline of his whole career See also Callaghan, E B (ed), *Documents Relative to the Colonial History of the State of New York* (Albany, 1853–87) (hereafter cited as *N Y Col Doc*), VII 175

[3] *N Y Col Doc* , VIII 813, note [4] *Ibid* , II 1006

[5] *Ibid* , VIII 659; *Quarterly Journal of the New York State Historical Association* (hereafter cited as *N Y Quart Journ*), IX 240

to inherit a large part of his father's estate[6] Wishing to protect amply as well as to provide for his favorite daughter, Mary, and at the same time to further Colonel Guy's fortunes, Sir William had made his nephew an executor of his will[7] and had also written General Gage recommending that Colonel Guy be promoted from deputy to superintendent in event of his own incapacity[8] No record has been found of Gage's reply to this request, but upon Sir William's sudden death, attributed to overexertion during an unusually large Indian council at Johnstown, Colonel Guy carried the business of the council to a successful conclusion[9]

Almost immediately thereafter his office became the center of a rising storm of revolution in Upper New York State The trouble began in an apparently trivial incident Colonel Guy, exercising his powers as magistrate, caused the arrest of two Massachusetts men sent by the Schenectady revolutionary committee to stimulate the local Tryon committee, which had been overawed and held in check by the Johnson forces The arrest stirred up a veritable yellow jackets' nest The local committee repudiated the authority of the sheriff and the magistrate and proceeded to elect others in their place In order to intimidate Colonel Guy a series of threats were made against his life and the safety of his family, which he countered by an attempt to rally the Iroquois to his cause By May 25, 1775, he had succeeded in getting only the Mohawks into council at Guy Park, situated on the Mohawk River in the extreme eastern part of Tryon County, but at this time the Tryon County revolutionary committee, by a series of meetings, forced his hand[10] On May 29, evading the vigilance of that committee, he moved his family and entire retinue from Guy Park Manor to Cosby's Manor,[11] near the headwaters of the Mohawk River and adjacent to the northeast section of the area then called "Indian country."[12]

[6] Dailey, Rev W N P, *Sir William Johnson, Baronet, Sketch of His Life* (St Johnsville, N Y, 1930), p 10 Sir William Johnson had aggrandized "an estate of two hundred thousand acres, the largest in the world at the time, [which] was not in accord with the growing spirit of democracy in the new world"

[7] See *ibid*, p 23, for a copy of Sir William Johnson's will

[8] Timson, George E, "Sir John Johnson, Indian Superintendent, 1782–1830" (MS), p 4

[9] *N Y Col Doc*, II 1006

[10] Campbell, William W, *Annals of Tryon County* (New York, 1831), p 21

[11] *Ibid*, p 35. Colonel Guy held a conference with General Herkimer there on June 6

[12] *Ibid*

The success of the Tryon committee in raising strong opposition to Colonel Guy compelled him to withdraw farther, to Fort Stanwix, and Governor Carleton, of Quebec, instructed him to relieve still more the pressure on his forces by moving to Fort Ontario, at Oswego Here he met 1,340 Indians in council on July 8 Three days later his thirty-one-year-old wife died, on the first anniversary of her father's death The terrors of the previous months combined with the hardships of the flight to Oswego from Guy Hall, near Johnstown, had been too much for her frail body [13] The next day, July 12, 1775, Colonel Guy assembled his cortege, which included two hundred and twenty Rangers, some eight hundred Indians besides his retinue, his two small daughters, and his wife's body, and moved down to Montreal

On the day on which Colonel Guy left Oswego Congress established an Indian Department of three divisions, with Major General Philip John Schuyler as one of the five commissioners of the Northern Division In this capacity Schuyler met about five hundred Indians in council and distributed £1,500 in presents [14] That act of Congress creating the Indian Department for the United States marked the beginning of an agency which was to develop an organized resistance to those British forces subject to Colonel Guy's control Under Schuyler's skillful organization two of the Six Nations and those portions of the other four who refused to follow the leadership of their Mohawk sachem, Joseph Brant, in joining the British and thereby jeopardizing their holdings in New York Indian country secured to them six years earlier, formed an Indian group which became the nucleus of all Indian opposition to the British The leader of this group was the Chief Corn Planter, Henry O'Bail, a half-breed Seneca

At Montreal Colonel Guy organized the Indians of that region and, with those who had accompanied him, attempted to assist in the defense of Fort St Johns, located on the Sorel River about twelve miles north of Lake Champlain, which was under attack by Montgomery and Schuyler, preliminary to an attack on Montreal and Quebec The four months' struggle for the possession of Fort St Johns terminated in its surrender to the intrepid Montgomery on November 2 His capture of Montreal followed ten days later. Governor Carleton, Colonel Allan McLean, of the Royal Highland

[13] *N Y Quart. Journ.*, IX. 242 [14] *Ibid*

Emigrants, and Major Preston, who commanded at Fort St Johns, escaped separately and reunited at Quebec [15]

When in council at Oswego the Indians had agreed, at Colonel Guy's urging and influenced by the schism which resulted in some of their members joining Schuyler, to assist the British in the struggle just beginning While the American attack on Fort St Johns had been forming, Colonel Guy had been undertaking the reëstablishment of his authority in the Mohawk Valley in order to assist the British in New York to relieve the pressure on Boston, or, in the eventual failure of such plans, to conduct raids into New York His proposals did not, however, fit in with the ideas of Governor Carleton, whose long experience in America had made him thoroughly distrustful of using Indians in any manner against the white man He considered that they were capricious, inconstant, and intractable, that their ideas of war and courage were totally different from those of civilized nations, that their object and design in all wars was not to fight, but to murder, not to conquer, but to destroy — in a word, that their service was uncertain, their rapacity insatiate, their faith ever doubtful, and their actions cruel and barbarous [16] For the same reasons his successor, Haldimand, with thirty years' experience in American colonial military activity, held a strong aversion to employing Indians in any capacity On the other hand, the Ministry (particularly after the issuance of the Declaration of Independence), as well as that part of English officialdom which felt any means to be justifiable that would soonest suppress the rebellion, favored making use of the Indians against the colonists and freely criticized Carleton's refusal to do so This fundamental objection of both Canadian governors to employing red men in warfare was the key to the perpetual conflict between the governor's office and the Indian Department from the beginning of Colonel Guy Johnson's troubles in early 1775 to the effectuating of the Jay Treaty and the concomitant retirement of Carleton, a second time, from the governorship, in mid 1796

Thoroughly angered because Carleton had refused to permit him to loose his savages upon Montgomery at Fort St Johns, further incensed when Carleton forbade his taking any Indian or Loyalist forces outside his immediate jurisdiction,[17] and frustrated because,

[15] *Annual Register* (London), 1775, pp. [4–7] [16] *Ibid*
[17] Can Arch , Q, XI 257, 261

though holding his commission of Indian office from General Gage, whose authority did not extend far west of the Hudson River, his military duties, Indian protégés, and most of the Johnson estates had fallen into the areas now clearly within the jurisdiction of Carleton, Colonel Guy placed his deputy, Major John Butler, in charge of Indian affairs for the Northern Department, angrily left Carleton and his harassed staff in Quebec, and in November, 1775, sailed for England His going was further motivated by the fact that his own and Sir William's estates direly needed the attention of their London agent [18]

Colonel Guy arrived in London to find that several changes had taken place in the cabinet At the time when the British forces were withdrawing from St Johns on the New York frontier Lord George Sackville Germain had been made Secretary of State for the American Department [19] Just what Johnson did while in England is not clear, but inferences may be drawn from his later relations and actions in America He seems, at any rate, to have attached himself to the North-Germain faction and to have entered into the general intrigues between the Germain party and the opposing colonial officials for placement and advancement in office It is evident that he threw his weight with the Court party, and, if he did not deliberately undermine the position of his superiors in America, he at least made no effort to cooperate with them Without Carleton's support, perhaps even in the face of his opposition, he secured a new commission directly from the King His influence with Lord Germain after his return to America is evidenced by a letter of March 26, 1777, from Germain to Carleton, directing him to have the Indians assembled and launched in "making a Diversion and exciting an alarm upon the frontiers of Virginia and Pennsylvania " [20]

[18] Can Arch , B, CVI 1-7

[19] Germain's appointment was made on November 10, 1775

[20] *Michigan Pioneer and Historical Collections* (hereafter cited as *Mich Pion. Coll*), IX 347 In a letter of September 26, 1777, from Carleton, at St Johns, to Henry Hamilton, at Detroit, it is obvious that Carleton keenly felt his humiliation "The conduct of the War has been taken entirely out of my hands, and the management of it, upon your Frontier has been assigned to you, as you have seen by a letter from Lord George [Germain], a copy of which I sent you [from Quebec, May 21, 1777]; I can therefore only refer you to that " *Ibid* , p 351 And on March 14, following, he wrote· "The Instructions sent out last summer by Lord George Germain were so pointed, taking the Management of the War on all sides out of my hands, that I cannot give you any directions, relative to the offensive measures you agitate " *Ibid*

It was generally known at that time in both England and America that Germain planned the ill-fated American campaign of 1777, to its minute details, without consulting his American commander-in-chief, Sir Guy Carleton, without even taking the trouble to notify him of orders issued directly to his subordinates Sir William Howe, for instance, informed his superior, Governor Carleton, that the concerted operations of the campaign on his side would lead him to such a distance as to render any communication concerning such orders impracticable [21]

Johnson landed at Staten Island on July 29, 1776, and remained in New York until September 10, 1778 Besides performing his duties as executor of the Johnson estates he spent part of these two years as manager of the Old Theater on John Street It was his intention to develop military coöperation between the British and the Indians along the New York frontier, but he was unable to accomplish anything in his Indian plans from this city, although he claimed the credit for organizing and directing the attacks which resulted in the Wyoming and Cherry Valley massacres

Meanwhile Carleton carried on his Indian relations with the resident deputy, Major John Butler, and ignored the Superintendent in New York Butler appears to have had little, if any, cooperation from his superior during this period In the summer of 1778 Carleton, snubbed and left unsupported by the Germain party in England, resigned and was succeeded by Sir Frederick Haldimand

Upon Carleton's departure from Canada Colonel Guy left New York for Quebec, but on account of bad weather and other adverse sailing conditions his ship was obliged to put in at Halifax [22] On October 20, 1778, he wrote Haldimand of his detention, and on the following May 6 again wrote Haldimand that he could not proceed to Quebec with Major Holland because he was unable to carry the bulk of his papers [23] He succeeded in sailing from Halifax in June, but on his arrival in Quebec did not receive any too hearty a welcome from Haldimand, who had known him from the time of the French attack on Oswego in August, 1756 Haldimand had been well satisfied with the services of Major Butler, and, partly because of Colonel Guy's long absence from his post, he did not regard him

[21] *Annual Register*, 1777, p [142]

[22] Can Arch , B, CVII 1

[23] *Ibid* , p 7 These papers were ones dealing with personal affairs, the Johnson estates, and the Indian Department

as faithful to his duty After arriving in Quebec the latter wrote a lengthy report to the Governor covering his protracted absence and detailing in excuse the pressure of his personal affairs, which had necessitated his trip to England in 1775, his long detention in New York, and the nine months of difficulties in reaching Quebec He referred to his great personal losses, expressed his earnest desire to gain a reputation as a useful officer, and gave as his reason for wanting to return as soon as possible to his post at Niagara the need for his being at the central seat of Indian operations [24] For another month he importuned his reluctant superior for permission to reassume his official position as head of the Indian superintendency at Niagara Finally, alarmed by reports from Butler and Joseph Brant of the American raid on the Indian country in Central New York, Haldimand realized that it was important that the officer charged by the King with the responsibility for Indian relations be no longer kept from his post of duty,[25] and on August 12, 1779, he granted Johnson the necessary permission to proceed to Niagara At the same time Haldimand issued instructions to Johnson on the course he should follow in military operations from that post He indicated that Colonel Guy's authority was limited to the supervision of the Indian Department and that he should so conduct the affairs of his office that the Indians would act as auxiliary forces to the regular troops He turned a deaf ear to Colonel Guy's urging military office for himself on the plea that military command would render his Indian operations more effective, for Haldimand had no idea of subordinating the efficient Colonel Allan McLean, who commanded all the military forces at Niagara and the posts above on the Great Lakes, to Colonel Guy, of admitting him to his official family, or of granting him any power or authority beyond the commission he already held He did, however, furnish him with a small vessel and sufficient supplies to carry him and his party to Niagara, permitted him to issue commissions to a specified list of Indian agents, supplied him with arms and ammunition, and urged on him the exemplary conduct of his office at Niagara, but he acted for the good of the service, not from any willingness to advance the other's fortunes [26]

[24] Can Arch , B, CVI 1–3, CVII 9–17.
[25] *Ibid* , CVII 17 (Butler's report, July 24), 20 (Brant's report, August 9)
[26] *Ibid* , pp. 24–30, 35, 42, 50

Colonel Guy wasted no time in assembling his resources and starting for his post, but he had not finished with Haldimand On September 5, writing from Montreal, he sent to Lord George Germain a detailed report of his movements since arriving in New York three years earlier, and charged that his delay in leaving New York, his detainment in Halifax, and the undue detention in Quebec from his post of duty were attributable to the specific orders of Carleton and Haldimand He informed Germain that he was now on his way to Niagara and that the American drive into the Indian country in New York was throwing all the inhabitants into a panic, for they feared the fall of Fort Ontario, across the mouth of the river from Oswego, and the loss of all sources of food supplies, as well as the destruction of their stores Suggesting that the Loyalists be organized into corps and that regular troops be sent to assist the Indians, he wrote of his confidence of success if given field rank and the support of Haldimand [27] A second report to Germain, dated November 11, and composed in a familiar and confidential tone, gave an account in detail of his proceedings since the letter of September 5 [28]

Three months later the Governor fired a heavy gun at the Indian Superintendent Haldimand was particularly aroused by instructions from Germain which seemed to follow promptings of a subordinate and which ignored his own recommendations About the same time, or just after these instructions were received, some recommendations arrived from Colonel Guy which apparently dovetailed with them This fired the fuse The Governor lashed out at the Superintendent, expressing his surprise that "you should make such proposals for raising corps and recommend measures that are impracticable in the Province of which I am Governor and for the army of which I am Commander-in-Chief Your letter has been forwarded to Lord George Germain and a request sent for copies of all letters on business from you " [29] Colonel Guy patched up the breach with Haldimand and seems to have sinned in this respect no more, if one can judge by the absence from the records in the Canadian Archives of any further correspondence with Germain

[27] *Ibid.*, p 31. [28] *Ibid.*, p 59

[29] *Ibid*, p 72 No copy of the letter or report from Colonel Guy Johnson has been found. Haldimand probably forwarded it without making a copy This letter from Haldimand on February 10, 1780, implies its content, however

The constant Indian raids upon the frontier settlements of New York and Pennsylvania, and even into Virginia, culminating in the massacres at Wyoming and Cherry Valley, provoked the colonists to an organized effort in 1779 to wipe out those tribes of the Six Nations responsible for most of the trouble Accordingly, General John Sullivan was sent with a large contingent of Congressional troops to act in conjunction with the state militia under Colonel Brodhead The two forces launched their attacks early in the summer of that year General Sullivan invaded the Seneca country along the upper Genesee River The whole region was laid waste, the towns were leveled, and even the orchards and the growing crops were cut down, trampled, and destroyed, while the stores of cured corn laid up for a two-year emergency were burned Colonel Brodhead treated in like fashion the region south of the country visited by Sullivan Only six small towns on the Genesee, the largest with but six habitations, and a few towns west of it escaped spoliation, and even here the supply of food was soon exhausted in feeding the fugitives [30]

As soon as reports of the magnitude of the American plans were brought in by Indian spies the British undertook a counterattack Colonel John Butler organized a defense and in July sent his Indian warriors, supported by his Rangers and also by Sir John Johnson at the head of four companies of his Royal Greens, to meet the attack These forces engaged in battle, first at Newton on August 28 and then at Chemung on the following day [31] General Sullivan, using cannon, utterly routed the eight hundred British-Indian allies and pressed on toward Niagara Butler steadily resisted Sullivan's advance, however, and the projected campaign aimed at Niagara was abandoned, but not before the complete despoliation of the Indian country had been accomplished The Six Nations never recovered from this reverse [32]

These events took place at the very time that Colonel Guy was making a belated return to his command On September 8 he reported to Haldimand from Montreal that he had collected such

[30] An account of this expedition, with considerable detail, is included in extracts from an officer's MS journal given in Campbell, *op cit*, pp 120–128

[31] *Ibid*, see also Van Tyne, C H, *The American Revolution* (New York, 1905), p 250, giving Sullivan's official report and citing as the source Cook, *Sullivan's Indian Expedition*, p 296

[32] Campbell, *op cit*, p 132

articles and supplies as were needed for the trip to Niagara The fact that part of the regiment of his brother-in-law, Sir John Johnson, had been sent along with them from Montreal had heartened the Indians' *esprit de corps* He had received, Colonel Guy reported, many accounts of the approach of the rebels to the Seneca country and would leave the following day (September 9, 1779) by the shortest route through Lake Ontario to Niagara He closed with what appears an insignificant request that Colonel Claus "desires the Six Nations disbursements be included in my accounts "[33]

Colonel Guy reported again from Cedar Landing on the eleventh and from Lake St Francis on the sixteenth At the latter place he began to meet refugees from the Seneca country, who brought accounts of the destruction and havoc effected by the forces under General Sullivan The Superintendent indicated that he would take the fleeing officers and Indians back with him and that he hoped to give a good account of his success with the rebels[34] According to his report on the thirteenth, his party, consisting of eighty white men and one hundred and twenty fighting Indians with their squaws and children, had arrived at Carleton Island two days earlier By the thirteenth, then, he knew the extent of the disaster to the Indian cause in the Seneca country, and warned Haldimand that the "distress of the Indians will cause an immense consumption of provisions" and that he had purchased a quantity of Indian goods in anticipation of a delay in receiving such supplies from England and had drawn on Haldimand for the purchase price[35] At Oswego, on October 15, Colonel Guy drew a dreary picture Sir John Johnson had arrived from the upper Genesee, and the Superintendent, after a conference with him, with the refugee Indians from the Genesee country, and with the Indians from the Niagara region, had decided to employ the Indians all winter in scouting On October 18 Haldimand, acknowledging the bills and informing Colonel Guy that Butler had carried on the business of the Department successfully, warned him to exercise care to lessen the enormous expenses being incurred[36]

[33] Can Arch, B, CVII 42 [34] *Ibid*, pp 36, 38

[35] *Ibid*, CVI 8, CVII 39

[36] *Ibid*, CVII 48 A census taken by the Indian agents a few weeks later indicated that there were about forty-five hundred Indians in the Niagara area dependent upon that post for subsistence, care, and shelter after the American raids into their country in New York and Pennsylvania had driven them from their homes and had destroyed all their means of subsistence

The Superintendent proposed to Haldimand that the dispossessed Indians be settled upon lands adjacent to Niagara, where they would be under the protection of that post, and that they be supplied with seed, stock, and such essential tools as were needed to plant, cultivate, and harvest their crops In this way, he declared, they would again become self-supporting and would be firmer allies of the British government The report which Colonel Guy made to Lord George Germain at this time [37] indicates the action he had taken to alleviate the hardships of the Indians, as well as something of the permanence of the hostility of the Indian agents toward the American cause He wrote, in part

> In a former letter I have informed your Lord^{p} of my having prevailed on many of the Indians who for their faithful services and sufferings expected to be maintained here during the War to go on planting grounds at a convenient distance from hence, and the great expense and difficulty attending the Transport of provisions to this Post, having made it necessary to get as many as possible to withdraw, I have been indefatigable in my endeavors for that purpose, and can now assure your Lord^{p}, that I have re-established near four thousand of them, tho' at much expense, as by the destruction of their country in 1779 [they have no resources]   neither was it prudent to refuse a people, who independent of their sacrifices for Govern't are the security in a great measure for all this communication and who give the example to the rest [38]

And again

> Some endeavors have been lately made by the Rebels to draw them [the Indians] into a neutrality which most of them disdain, I hope shortly to put an end to such attempts as well as to reconcile the Indians to the plan of Œconomy now entered upon for reducing the expenses which however enormous, was for a time unavoidable [39]

Haldimand acted to support the measures already taken by the Indian Department On July 13, 1780, nearly a year after Butler's defeat, he ordered Colonel Mason Bolton to settle families at Niagara and at "the several posts in the Upper Country" in order that they might reclaim and cultivate lands and so furnish supplies for troops and Indians He directed that every possible measure be taken to promote the strength of the posts and to protect them and the country, including that of the Indians, from the rebels.[40] Again, on April 24 of the following year, he wrote Colonel Guy that he had ordered settlements of the Loyalists to be made around the western

[37] *N. Y. Col. Doc*, VIII 813, Letter No 17, Oct 11, 1781, Colonel Guy Johnson to Lord George Germain [38] *Ibid.* [39] *Ibid*

[40] *Mich. Pion. Coll.*, XIX: 543

posts to strengthen them against the Americans[41] Colonel Guy, as has been said, also took action to provide for the relief of the Indians He bitterly resented all attempts to ally the Indians or to reconcile them in any way to the American cause In order to fortify the Loyalists in Canada, protect them from American attack, and render secure the bordering territory of northern and western New York for the King, he undertook, with Haldimand's approval, a readjustment of the benefits for the Six Nations and a relocation of their settlements Two entire tribes and a part of a third refused to leave New York territory and were settled to the east and south of Lake Ontario, along the Niagara River and the eastern and southern border of Lake Erie Locations were found in Canada for those of the Six Nations who were willing to migrate

Another side of Colonel Guy's official character led to results which eventually greatly increased the difficulties of Great Britain and the United States in arriving at a mutual understanding over the settlement of the boundary Had he possessed the ability, honesty, and courage of his predecessor, the traders and the others who exploited the Indians would never have become so thoroughly entrenched in their control of Indian affairs that it would take thirteen years for the British government to dislodge them As superintendent he displayed a degree of ineptness and moral irresponsibility which was a strange contrast with the reputation he had gained while acting under Sir William as deputy Arthur Pound, Sir William's biographer, recounts that Colonel Guy's first act upon arriving in America was to borrow money from a total stranger, which his uncle had to repay,[42] but he states that Colonel Guy was popular with the Indians, an adept at garnering offices, and that, had he not been confronted with the excitements of revolutionary unrest, he would have continued his uncle's policies with ability As a deputy he had exercised restraint in the use of liquor, but as superintendent he became increasingly inebriate[43] After his return from England he approved unverified and unchecked bills submitted by the traders at Niagara, Detroit, and elsewhere for supplies which had been advanced to the Indians on his request or on that of his agents and at grossly exaggerated prices. He ap-

[41] *Ibid.*, p 628.

[42] Pound, Arthur (Day, Richard E , collaborator), *Johnson of the Mohawks* (New York, 1930), p 430

[43] *Ibid* , p 431

proved bills for goods which were never delivered to the Indians because the traders advanced them to their agents, who, in turn, either lost them by theft, storm, or gambling, or else absconded with the receipts

The trial of Colonel Guy Johnson, which took place in Quebec in 1781–83 and which was reopened on appeal in England in 1784, did not prove him dishonest Instead, the testimony indicates that he inherited from Sir William a confused and intricate business system based largely on family ties Among his official paid subordinates in the Indian Department were relatives who not only transacted the King's business but at the same time carried on extensive dealings with the Indians for personal profit George Croghan, another son-in-law of Sir William, was, for instance, deputy Indian superintendent at Fort Pitt and was simultaneously engaged in numerous private enterprises with both white traders and Indians [44] Colonel Daniel Claus, still another son-in-law, was a deputy, interpreter, and a not-so-successful businessman [45] The administration of the whole Department was careless, lax, and indifferent, having for its local objective a sort of American feudal aggrandizement of the Johnson fortunes, with the government paying for essential official services The concept of civil and imperial responsibilities was very weak, and ill understood by the Superintendent Carleton, a successful businessman, was keenly alive to the responsibilities of public office Haldimand, who had never engaged in private business, was particularly sensitive to the need for honesty in public office and was, for these reasons, short of patience with Colonel Guy The exigencies of a war breaking almost immediately upon his assumption of the superintendency left no time to reform the procedure and practices, even had he so desired

It was in this way that Colonel Guy became an integral part of the systematic connivance and corruption which prevailed between the traders at the interior posts, Oswego, Niagara, Detroit, and Michilimackinac, and the officials stationed there to represent the interests of the King The difficulties inherent in the situation grew

[44] Volwiler, Albert T., *George Croghan and the Westward Movement* (Cleveland, 1926), pp 121, 126

[45] Eight volumes of Claus Papers in the Canadian Archives give ample evidence of such shortcomings These papers reinforce Croghan's constant complaints that the Indian agents had to advance personal funds in performing their imperial duties.

as time passed The prolongation of the war made the British increasingly dependent along the frontier upon the friendship and support of the savages The customary annual presents had to be augmented beyond the requisitions submitted by the Indian agents and the commanders at these posts, and more than either Carleton or his successor, Haldimand, would authorize [46] Furthermore, the hazards of war repeatedly slowed up delivery of even such goods as had been allowed on the original requisitions, and if this supply did not arrive before the close of the navigation season on the inland waters it was held over at Quebec, Montreal, or Carleton Island until navigation opened again Whether the goods failed to reach the posts early enough for the annual distribution of presents to the expectant Indians or whether an inadequate supply did arrive in time, the result was the same the Indian agents, confronted by an assemblage of expectant savages, had to appeal to the post commanders to borrow or buy enough goods from the local trading firms to tide them over until the arrival of the next shipment This supplemental trade at the four posts mentioned grew to great proportions before the end of the war, and even then did not lessen appreciably for several years, neither was the concomitant graft ever completely eradicated so long as these posts were retained by the British

The commandants were often personally involved with the trading firms, sometimes through living beyond their means and sometimes because, their pay or allowances being long overdue, they were compelled to open charge accounts or to ask for advances against which they pledged their delayed incomes In the face of positive and oft-repeated instructions from Quebec forbidding the Indian Department to borrow or buy Indian goods from the traders, the practice went on until the British withdrew from the American side of the line The same situation obtained for necessary garrison supplies, for some luxuries, and always for rum Probably it was in part unavoidable Meal, meat, and flour were frequently reported to have spoiled while *en cours de voyagé*, and the frontier thirst seemed ever unquenchable It apparently was officially accepted in Detroit that a carpenter, soldier, or artificer working on repair

[46] *Mich Pion Coll*, X 632, gives an estimate for 1782 of Indian goods to be used at Detroit; *ibid*, XIX 517, presents an inventory of Indian presents designated for Michilimackinac on May 13, 1780

of the stockade required from a pint to a quart (the minimum, according to one letter to Haldimand) of rum per day to revive his flagging spirits Haldimand's opinion was that a gill a day per man was all that good health would permit in Quebec [47] But the commissariat at Detroit replied that shipments of rum were sometimes watered on the voyage [48] During the war the bills for such goods furnished by the traders at Detroit alone, when presented at Quebec, averaged about £10,000 a month Haldimand faced a dilemma he was torn between demands for increases from the posts and orders from London to reduce the amount of supplies issued

The bills with the traders at Michilimackinac approved by the commandant, Patrick Sinclair, doubled then tripled in the two years prior to October, 1781, when they amounted to £57,000 At that time Sinclair was summoned to Quebec, precisely when Colonel Guy Johnson arrived there for a protracted hearing on his accounts at Niagara Sinclair was detained in the city two years waiting for a settlement of the charges against him, his repeated requests to be allowed to go to England being refused by Haldimand At last successful in getting such permission shortly before Haldimand himself left Canada, the commandant was arrested soon after his arrival in England upon complaint of the holders of the bills Haldimand had protested and was not released from Newgate Prison until he paid them Upon being freed from prison, Sinclair proceeded to start suit to recover on these bills from Haldimand, but the government, acting on the policy that the principal is responsible for the acts of its agents, seems to have accepted, approved, and paid the bills, reimbursed Sinclair, and settled the case [49] That there was justification for repair expenditures at all three posts, Michilimackinac, Detroit, and Niagara (where Colonel Guy outfitted for himself at government expense the finest dwelling within the ramparts), is undoubtedly true The decision to move the fort from Michilimackinac to Mackinac Island had been officially approved [50] At

[47] *Mich. Pion. Coll.*, IX 408, X 345

[48] It seems to have been a deck-hand practice to drive up a hoop on a rum barrel, bore a hole, withdraw a quantity of rum, replace the rum with water and pepper, plug the hole, and drive the hoop down The perpetrators of this trick maintained that such diluted, peppered rum was really better for the Indians than the unadulterated article

[49] *Mich. Pion Coll.*, XXXIX: 80–82; IX 516–618, *passim.*

[50] *Ibid*, XXXIX: 76.

Detroit the huge repair expenditures were inevitable, since the fort and stockade had been allowed to fall into such a state of disrepair as to be indefensible It is clear that this weak condition of the stockade was a consideration in increasing the quantities of presents dispensed to the Indians [51] The tremendous bills incurred at Niagara were repeatedly justified by Colonel Guy on the score of Britain's responsibility for feeding, sheltering, and relocating the hordes of Indians driven out of the Mohawk Valley and Upper New York State the previous year [52] At first Haldimand had approved of these plans, but he was "shocked and alarmed at the enormous expenditure" when the bills were presented [53]

Yet bad as was the corruption at Detroit and Michilimackinac, it was worse at Niagara Not only did the firms which supplied the goods keep the only records and accounts, but they rendered unaudited, unchecked bills to Quebec for goods, provisions, and the like, which they claimed to have advanced out of their own stores, at most extravagant prices [54] Officially, Colonel Guy was responsible for the continuance of this lax system in the Indian Department and for the attendant corruption It grew to maturity after he turned full charge of the Department over to deputies and during the period of almost four years when he was absent from his responsibilities, for during that time the activities of the Department expanded from peacetime functions to measures which had to meet all the emergencies of war Six months before summoning Sinclair to Quebec for an accounting Governor Haldimand had discovered malfeasance in a £35,000 bill of goods for which Colonel Guy had drawn on the government for expenses at Niagara Further investigation disclosed that corruption had spread through the whole Indian Department [55]

Haldimand first brought the firm of Taylor and Forsyth, which had furnished large quantities of the goods at Niagara, to trial for fraud [56] It soon became evident that Colonel Guy's private dealings with the firm were badly mixed with the public ones [57] The trial lasted two months and eventually had to be settled in England on

[51] *Ibid*, p 80
[52] Can Arch, B, CVII 83–86, 92, 96–97
[53] *Ibid*, pp 104–108, LIV 343
[54] *Ibid*, CVII 198–199, CIX 110, 112, 154, 237
[55] *Ibid*, CVII 92, 262–267, CVI 58–67, CIX. 132, 152
[56] *Ibid*, CVII · 278 [57] *Ibid*, CIX 198

appeal by Taylor and Forsyth In the course of these proceedings Colonel Guy's accounts proved so involved that his trial in Quebec dragged out over two years Haldimand forced him to produce all financial records of the Department beginning with the time he had taken over the office in 1774 Much of the difficulty had to do with accounts involving Indians and Indian agents who were illiterate and who could not sign vouchers, or did not know what they had signed when they came to testify, or did not know what they were testifying about

Though Haldimand does not seem to have exceeded the technical powers of his office, the impression in London was that he certainly left no stone unturned in his efforts to rid himself of the Indian Superintendent The records of the trial run into several volumes, each of several hundred pages [58] Since Colonel Guy's commission was beyond the reach of dismissal by a governor general, Haldimand took advantage of the change of ministry following Lord North's fall to secure the appointment of Sir John Johnson, who was entirely without knowledge of the nature of the charges against Colonel Guy, as is evidenced by the fact that three times during 1782 and 1783 he requested that his brother-in-law be assigned to serve with him at Niagara [59] Haldimand received a judgment against Colonel Guy for about half the amount involved,[60] but at this point the latter obtained from the court a stay of execution and a transfer of the suit to England

A few months after Colonel Guy's departure Governor Haldimand gave up his office and also retired to England Colonel Guy started suit in the English courts to have the findings of the military tribunal set aside, brought charges against Haldimand for defamation of character, and appealed for a restitution of property seized by Haldimand in partial satisfaction of the judgment rendered by the military court But Colonel Guy's death on March 5, 1788,[61] occurred during the long trial Later, at its conclusion, the court issued a decree which set aside Haldimand's judgment, held Colonel Guy only collaterally responsible for the corruption found in his office, returned a part of the seized property, and compelled Haldi-

[58] Can Arch, B, CVI-CX, CXII, CXIII, CXV, CXXIII, *passim*
[59] *Ibid*, CVIII. 40, 187, CVI 96, 98, CXV 110
[60] *Ibid*, CX 43-77, 279.
[61] *Gentleman's Magazine* (London), March, 1788, "Obituary"

mand to pay approximately £5,000 damages to Colonel Guy's estate for loss of rank and prestige and for character defamation This record speaks for itself

Like many another Loyalist, Colonel Guy had returned to England on the officers' list, at half pay,[62] and had attempted to secure compensation for his personal property and for his estates in the Mohawk and Hudson River valleys which had been confiscated by the state of New York under the Confiscation Act of October 22, 1779 These estates were extensive according to an itemized list of money and properties left him by Sir William Johnson,[63] but Colonel Guy died in his London home in the Haymarket before the claims of the Loyalists had all been heard by the commissioners of claims

Among the last of the official records in America relating to Colonel Guy Johnson is an entry in the minutes of Lord Dorchester's Council for December 29, 1788, citing an application by Sir John Johnson for one thousand acres of land on the south side of the Ottawa River and entering an order of the Council to the surveyor general that a survey be made and, when that had been done, that the land be granted to the heirs of Guy Johnson, deceased [64]

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[62] *N Y Quart Journ*, IX 249
[63] Stone, William L, Jr, *Life and Times of Sir William Johnson* (Albany, 1865), II 490–502
[64] Ontario Bureau of Archives, Report, 1905, pp 413–414

HUGO GROTIUS ON THE FREEDOM OF THE SEAS

ALBERT HYMA

HUGO GROTIUS was first called Huig de Groot, being the son of Jan de Groot and Alida van Overschie His father was a member of the municipal council of Delft, and from 1594 to 1617 served as curator of the University of Leiden From 1591 to 1595 he was mayor of Delft, the city in which William of Orange, founder of the Dutch Republic, had been assassinated in 1584 Here the most illustrious members of the House of Orange-Nassau were buried, in a church that may well be called the Westminster Abbey of the Dutch people Moreover, when Grotius, at the age of eleven, matriculated in the University of Leiden, his uncle, Cornelis de Groot, was rector of this institution

After having studied at Leiden for four years, Grotius took a trip to France, on his way to Orléans he joined the legation under Justinius of Nassau and John van Oldenbarnevelt At the University of Orléans he received the degree of Doctor of Law, although he apparently had not studied there at all To receive such a degree at the age of fifteen, besides a medallion portrait from King Henry IV of France, was definite proof of his father's prestige The young man was, however, exceedingly precocious In 1599 he published a splendid edition of Martianus Capella, one of the great textbooks used in the medieval universities [1]

Shortly before the end of 1599 Grotius established himself in The Hague as lawyer While residing there he learned of the capture by Dutch forces of the Portuguese vessel *St Catarina* Its cargo was sold at auction in Amsterdam, amidst the loud applause of Dutch imperialists, who dreamed of the conquest of the rich

[1] Meulen, J ter, *Concise Bibliography of Hugo Grotius* (Leiden, 1925), pp 5–6; Molhuysen, P C, *Briefwisseling van Hugo Grotius*, Vol I (The Hague, 1928), pp. xiii–xvi

Spice Islands and the trade with China and Japan.[2] Many interesting details of this exciting event are mentioned by Grotius in his brilliant work *De Jure Praedae* ("On the Law of Booty [Prize]"), which he composed in 1604.[3]

The question now presents itself: What were the relations between Grotius and the directors of the East India Company, who had become the owners of the captured prize? His writings show that he was very familiar with the whole case, and it is for this reason that certain authorities in America have argued that Grotius was employed as a legal adviser by the Dutch East India Company.[4] The problem has been carefully scrutinized by a competent Dutch scholar, P. C. Molhuysen, who came to the conclusion that Grotius was not engaged in this manner.[5]

The present writer, however, is of the opinion that, although Grotius was not officially the lawyer of the company, he certainly functioned as a legal adviser and was vitally interested in the management of this great corporation. He was strongly influenced by Jacob Boreel, one of its directors, whose son (John) had studied at Leiden while Grotius was there. Both John Boreel and Grotius married girls in the province of Zeeland, where Boreel lived. The two men were intimate friends and both were willing to serve the interests of the corporation in question. This appears from a letter, in Dutch, addressed to Grotius by the Zeeland Chamber of the company, and dated November 4, 1608. Here we read:

We have always been of the opinion that it would be desirable for the United Company to have the right of navigation which the Dutch nation enjoys over the free wide world thoroughly justified and reinforced with both natural reasons and the provisions of law. . . . That which we formerly regarded as desirable now appears almost necessary, at a time when negotiations are being carried on for a truce. . . . We have recently been strengthened in our purpose through the remonstrance of Mr. John Boreel, presented in our meeting, in which he pointed out the means of furthering our plans, saying that you had prepared all the necessary material for this subject, which we were pleased to hear. For that reason we have no doubt of your favorable disposition toward the United

[2] This subject has been discussed at some length in Chap. III of the writer's forthcoming book, *A History of the Dutch Empire in the Far East* (Albuquerque, New Mexico: University of New Mexico Press, 1942).

[3] Edited by G. Hamaker (The Hague: Martinus Nijhoff, 1868).

[4] Notably James Brown Scott, of the Carnegie Endowment for the Promotion of International Peace, who often stated this opinion to the writer.

[5] Molhuysen, "Over Grotius' De Jure Praedae Commentarius," *Bijdragen voor vaderlandsche Geschiedenis en Oudheidkunde*, Sixth Series, 4: 275–282. 1926.

Company, and we beg you to assist the said Company, nor do we doubt that you have likewise been requested to do this by the Chamber of Holland [6]

The material that Grotius is said to have collected was for the most part published under the title *Mare Liberum* ("On the Freedom of the Seas") It first appeared in 1609, in which year the Spanish and Dutch governments signed the Twelve Years' Truce The author's name was not revealed at this time, but the directors of the East India Company were well aware of his identity They also knew that his larger work, *De Jure Praedae,* included as a part of Chapter XII this very composition [7] Unfortunately, however, some of Holland's greatest authorities on the rise of the Dutch East India Company seem to have forgotten when the *Mare Liberum* was written [8]

As early as October 15, 1604, a letter had been addressed to Grotius by John ten Grootenhuys, whose brother Arent sent his best wishes "together with those of the other directors of the Company" [9] The directors wished to commit to Grotius the task of defending the Dutch merchants in the Far East against the "perfidious Portuguese," and John speaks with approval of Hugo's learned *De Jure Praedae* The letter is an apology for his countrymen, they have suffered terribly at the hands of the Portuguese "tyrants, murderers, pirates, and scoundrels," who are trying to close the Indian Ocean to the "unhappy and innocent" Dutch sailors and merchants Grotius must show the world the injustice of all this Although the letter was in Latin, Grotius wrote some comments on the margin in Dutch concerning the sale of the *St Catarina* and mentioning books dealing with Portuguese trade in the Far East [10]

In his first great work, *De Jure Praedae*, he argued in favor of

[6] See Molhuysen, *Briefwisseling van Hugo Grotius,* I, No 146 128–129 Translations from the Dutch are all by the present author

[7] Fruin, R , *Verspreide Geschriften*, Vol III (The Hague, 1901), pp 443–445

[8] *Geschiedenis van Nederlandsch Indië*, ed F W Stapel, Vol III (Amsterdam, 1939), p 8 "Het is een der merkwaardigste voorbeelden van de ironie der geschiedenis, dat Hugo Grotius in 1608 zijn Mare Liberum zou schrijven in zijn hoedanigheid van historiograaf der Vereenigde Oostindische Compagnie" These words are from Dr Stapel himself and reflect the popular ignorance in the Netherlands of the relation between Grotius and the great company in the years preceding 1609.

[9] Molhuysen, *Briefwisseling van Hugo Grotius*, I, No 53 44

[10] On October 20 Ten Grootenhuys sent Grotius another letter with reference to his commentary, and here also Grotius' remarks are written on the margin in Dutch

the free seas because his countrymen wanted a share of the trade with the Spice Islands Their aim was to break the monopoly of the Spanish and the Portuguese, who sought to close the Indian Ocean to other Europeans Very different was his attitude twenty years later when he perfected his most famous book, *De Jure Belli ac Pacis*. Here he presented a purely objective explanation of the principles of natural and international law [11] The material he wrote in 1604 remained unpublished until 1868, with the exception of that brief portion called *Mare Liberum*

De Jure Praedae consists of three parts The first discusses war and the taking of prizes, which is asserted to be justifiable on the grounds of international and natural law The second is historical in character, delineating the revolt of the Dutch against the Spanish government under Philip II and the maltreatment suffered by the Dutch merchants and sailors in the Malay Archipelago at the hands of the Portuguese The third part begins with *Mare Liberum*, which, contrary to the opinion of many writers, is only a portion of the twelfth chapter In this and the preceding chapter the author paints the deeds of the Portuguese in the darkest possible colors, while at the same time praising the Dutch, who so heroically captured their prize [12]

Mare Liberum was somewhat misunderstood at the time by an Englishman named William Welwood, who attacked Grotius' viewpoint regarding the freedom of the seas England sponsored the idea of a *mare clausum* around the British Isles, Dutch fishermen were not wanted near those coasts But Grotius in 1604 was not greatly interested in that issue He did, however, defend his *Mare Liberum* in a separate treatise, entitled *Defensio Capitis Quinti Maris Liberi Oppugnati à Gulielmo Welwodo*, it was first published in 1872 [13]

What neither William Welwood nor the great majority of commentators in the nineteenth century knew was that Grotius had been induced by friends of the Dutch imperialists to resent the cruelties alleged to have been inflicted by the Portuguese and the Spaniards upon the Dutch in the waters of the Far East He re-

[11] Vissering, S, "Over een drietal Handschriften van Hugo Grotius," *Verslagen en Mededeelingen der Koninklijke Akademie van Wetenschappen*, Afdeeling Letterkunde, 9 145–154 1865

[12] See especially Chap XI, Part I, Articles VI–VII, pp 170–175

[13] It appeared as an appendix to a work by S. Muller, *Mare Clausum* (Amsterdam, 1872), pp 331–361

peated almost verbally some of the ideas expressed by John ten Grootenhuys in his letter of October 15, 1604 But in the original version of *Mare Liberum* there is naturally no reference to the truce signed by the Spanish and Dutch governments in 1609 The thirteenth chapter in the later version of *Mare Liberum* contains new material, which fact is very often overlooked [14]

The main purpose of *Mare Liberum* is to prove that the Portuguese have no right to close the waters of the Indian Ocean to subjects of other European powers Their discoveries give them no title to such a monopoly, because they were by no means the first Europeans to navigate these waters Furthermore, as Victoria, the learned Spanish commentator on international law, had shown, the Pope had no legal right to give the East Indies to the Portuguese That leaves only the claim of a title through warfare If the Portuguese had carried on a war with the natives and had thus occupied the islands or coastal regions, their claim would have been sound, provided that they had had good grounds for war, which they did not have after all The Indian Ocean is not the property of any nation, but open and free to everyone The shore of the sea also is common property, except where someone has built a house or fortification, for then the land upon which the structure has been erected is private property It is even permissible for a person to fence off with stakes an inlet of the sea, and turn that into a privately owned fishpond.

These views, expressed in 1604 and repeated in 1609, were not fundamentally altered by the author afterward, either in 1613, when he was sent to England to represent the Dutch East India Company, or in 1615, when he welcomed the English commissioners as they were going through Rotterdam on their way to The Hague in order to negotiate with the Dutch concerning the freedom of the seas in the Far East It is quite true that in these later years Gro-

[14] It is rather surprising that the first sentence in the thirteenth chapter has been wrongly translated in the splendid edition published in 1916 for the Carnegie Endowment for International Peace (New York Oxford University Press) Here we read on p 72 "Wherefore . it follows that we are to maintain that freedom which is ours by nature, either by coming to a peace agreement with the Spaniards, or concluding a treaty [read 'truce'], or by continuing the war" The arrangement in the first draft of *De Jure Praedae*, 1604 or 1605, is very different The twelfth chapter is not called *Mare Liberum*, nor is *Mare Liberum* divided into thirteen chapters, but the whole of it into four sections or articles

tius remained a good patriot and a warm friend of the Dutch corporation, for which reason one is easily but wrongly led to the unjust criticism that his patriotism biased his legal opinion

The Anglo-Dutch conference of 1613 was a failure, largely because the English and the Dutch did not come to grips on the real issues debated Grotius, the principal spokesman for the Dutch East India Company, argued, as he had done before, that the seas were always free and open to everyone, and that the shores of the seas were likewise free But after private property had been built upon a shore, it ceased to be free to the general public The official report, written by Grotius in the Dutch language and addressed to the States-General of the Dutch Republic, was first published in 1928 [15] The complete records of the conference, in Latin, are now ready for publication [16] They do not seem to have been consulted by leading Dutch scholars, largely, no doubt, because in the Netherlands only a few fragments of them have been preserved

Few British and American experts, on the other hand, have used the important Dutch sources which show how strongly Grotius was influenced by the directors of the Dutch corporation On January 31, 1613, Jacob Boreel wrote these words to him "When you arrive in England, you will explain that they will not be able to trade so freely and so cheaply as we through and in the places which we have conquered and settled with our blood and property" [17] This letter contains very interesting material, but it was not published until 1928, which is true also of one addressed to Grotius in 1613 by Dirck Meerman, member of the municipal council at Delft He wrote. "As for the documents which you asked me to send to you, such as the proposition of Ambassador Winwood, the complaints of the English, and the message of the States-General, I have asked Mayor Paeuw for these" [18]

Another letter which throws light on the relation between Grotius and the Dutch East India Company is that addressed to him by Admiral C. Matelief, dated December 14, 1613 Matelief stated that King James I of England did not enable the English East India

[15] See Molhuysen, *Briefwisseling van Hugo Grotius*, I 626–635

[16] They will form Appendix B in the writer's forthcoming book (see note 2)

[17] See Molhuysen, *Briefwisseling van Hugo Grotius*, I, No 253 226–227.

[18] *Ibid.*, I, No 256: 229–230 Paeuw was the former mayor of Amsterdam and a man of great importance in the trade with the Far East See *Geschiedenis van Nederlandsch Indië*, III. 22, 29

Company to occupy and fortify important places in the Malay Archipelago The King preferred to depend upon negotiations with the representatives of the Dutch government, believing that they would be kind enough to let the English share in the Dutch trade This was a source of considerable satisfaction to the Admiral, who did not expect much result from mere negotiations [19]

It is clear that when Grotius was sent to England to represent both his government and the great trading company, he set forth views which he had borrowed largely from the directors in the company They told him in advance what to say Jacob Boreel informed him that when he (Boreel) was in England, he did not think it advisable to say much about the law of nations or about the right of occupation and the expenses incurred by the Dutch themselves On the other hand, Boreel emphasized what the English had done in and near Virginia, and how they asked foreigners a fee for sailing through Davis Strait They wanted a sum of five hundred dollars for each ship, because they had discovered the strait and expected others to pay for the benefit derived from the work of the English [20] In other words, the Hollanders must let their competitors know that the latter had inaugurated practices in America that would be equally valid in Asia They came to England well prepared to carry out these instructions

Robert Cecil, Earl of Salisbury and principal minister of James I, had informed Sir Ralph Winwood, the English ambassador in The Hague, that his countrymen were not to ask for indemnities but to insist upon the enforcement of natural law and the law of nations, according to which the seas and commerce were free to all peoples [21] It is remarkable that Salisbury in his letter to Winwood used almost exactly the same words as had Boreel in his epistle of January 31, 1613, to Grotius Salisbury argued that the Dutch, "contrary to the general law of nations which admits a communion and liberty of commerce," wanted to exclude the English from trading in the Far East This line of argument the English representatives in the Anglo-Dutch conference of 1613 continued to the very end [22]

[19] Molhuysen, *Briefwisseling van Hugo Grotius*, I, No 309 287

[20] *Ibid*, I, No 253 226

[21] *Winwood Memorials of Affairs of State*, ed E Sawyer (London, 1725), III 320

[22] See Clark, G N, "Grotius's East India Mission to England," *Transactions of the Grotius Society*, 20. 54–55, 63–81 1935 The report made by Grotius

Professor G N Clark in his excellent article on Grotius' mission to England expresses the opinion that when the English finally referred to *Mare Liberum* by Grotius they must have regarded this as their trump card [23] But neither the author nor any of his friends were at all embarrassed by the passages quoted from his little book It may have seemed strange to the English that the writer of *Mare Liberum* had been selected to defend the thesis that the Dutch colonies in the Far East were not free and open to all foreigners [24] However, he merely repeated what he had written before, namely, that after a nation has erected fortifications upon a shore and has signed contracts with the natives for the purchase of spices, competitors from other nations must expect to be subject to tolls at the very least Being the principal spokesman for the Dutch East India Company, Grotius penned some very important pronouncements on this question, which should have been published long ago

In August, 1613, when Ambassador Winwood was about to leave the Dutch Republic, Grotius wrote him an interesting letter. Since Winwood intended first to visit Amsterdam, Grotius had communicated with Mr Paeuw, the former mayor of Amsterdam, who had accompanied Grotius to London early in that year. Winwood would learn from Paeuw what the directors of the Dutch company thought about the situation in the Malay Archipelago The writer suggested that Winwood examine very carefully the intentions of the English directors in London, who were aiming at an open war with their Dutch rivals in the East Indian waters, and continued

> When I was in England I did not find a single person who showed the necessary resolution they talked of nothing but going to the East Indies and carrying on there a simple form of traffic I believe that an honest and equitable means will be found for compensating the Dutch for the expenses they have incurred thus far [25]

will appear, in English translation, as Appendix A in the writer's forthcoming book (see note 2), and this point will receive considerable attention in the text of that work

[23] Clark, *op cit*, p 79

[24] The present writer has talked with experts in the field of international law who believe that Grotius in 1613 contradicted the views he had advanced in 1604 They are mistaken.

[25] See *Historical Manuscripts Commission, Papers of the Duke of Buccleuch at Montagu House*, I (1899) 142–143 In this letter there appears the phrase, "une guerre royale et ouverte" Professor G. N Clark says in his article on Grotius' mission (*op cit*, p 74) that according to Mr R W Lee the word *royale* stands for *loyale*. But this obviously is an erroneous conclusion, since

The leading merchants in Amsterdam and Middleburg were fully aware of what Grotius had in mind In their opinion he would not in 1613 have to retract anything he had previously stated in his *Mare Liberum*, though this could not be said for the whole of *De Jure Praedae* The latter work had better remain unpublished, they reasoned When in 1614 a Dutch edition of *Mare Liberum* appeared, the Dutch imperialists were not displeased They expected much from Grotius His keen mind and vast learning could not fail to impress some of their adversaries On September 16, 1610, the executive committee of the Dutch East India Company had decided to "have the trade with the East Indies described historically by the fiscal Grotius, or some other learned person, in order to increase the honor and reputation of the Company and the country " [26] Although no definite action was taken beyond this statement of policy, the directors showed by their own words what they thought of the learned lawyer in The Hague They knew very well why they wanted him to represent them in London, and when in 1615 another Anglo-Dutch conference was held, this time in The Hague, they requested him once more to further their best interests [27]

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royale is often used in the Netherlands as meaning "on a large scale " This is exactly what Grotius had in mind The English were aiming at an open war that was to be fought on a large scale The experts of the Historical Manuscripts Commission gave us the correct version Unfortunately the letter in question does not appear in Molhuysen's edition

[26] Jonge, J K J de, *De Opkomst van het Nederlandsch Gezag in Oost-Indië*, Vol III (The Hague, 1865), p 379

[27] See Chap V in the writer's forthcoming book (see note 2)

THE INTERNATIONAL LAW OF STATE BOUNDARIES AND SUITS BETWEEN MEMBER STATES OF FEDERATIONS

JOSEPH A KITCHIN

FOR approximately forty years a considerable literature has been accumulating on the United States Supreme Court as a pattern for a world court in suits between sovereign states The famous statement of Justice Baldwin in *Rhode Island* v *Massachusetts*, 1838, that from the time of submission "the question ceases to be a political one to be determined by the *sic volo, sic jubeo* of political power, it comes to the court to be decided by its judgment, legal discretion, and solemn consideration of the rules of law appropriate to its nature as a judicial question, depending on the exercise of judicial power " [1] has marked the line of practically all research in this field Emphasis has been placed on breaking down the distinction between political and judicial questions, with but little attempt to analyze the rules of law which the interstate tribunal actually applies to such a case [2] Nor is Chief Justice Fuller's pronouncement that the court applies "Federal law, state law, and international law, as the exigencies of the particular case may demand," [3] much satisfaction for those who doubt that the judge can precede the legislator or that judicial lawmaking is adequate or trustworthy where sovereign rights are at stake.

The application of international law within a federation is neces-

[1] 6 Peters 675, 737

[2] See particularly Scott, James Brown, *Judicial Settlement of Controversies between States of the American Union* (2 vols and Analysis, Oxford· Carnegie Endowment for International Peace, 1918, 1919), Warren, Charles, *The Supreme Court and Sovereign States* (Princeton, 1924), Smith, Herbert A, *The American Supreme Court as an International Tribunal* (New York, 1920), Lauterpacht, H, *The Function of Law in the International Community* (Oxford, 1933), Appendix. "Limitation of the Judicial Function in Disputes between State-Members of Composite States"; and numerous papers in the *Annual Proceedings* of the American Society for Judicial Settlement of International Disputes, Washington, D.C, 1910, 1916.

[3] *Kansas* v. *Colorado*, 185 U S. 147 (1902)

sarily limited by the norms ready at hand in the constitution and by the restricted sphere of sovereign competence reserved by member states Furthermore, all state powers in most federations (except Germany, 1871–1919) derive from their constitutions and not directly from international law Consequently, it is not truly international law, but interstate law, which is applied to disputes between the states, and the factors common to both legal systems must be understood as by way of analogy, not identity [4]

The common constitution of a federal state defines and distributes many of the powers of government to the central and local units, but certain legal disputes between these member governments, such as cases of boundary claims or of tortious injury by one state to the property or citizens of another, lie outside the sphere of subject matter regulated by the superior norm of the constitution Here the constitution confers the jurisdiction, but no rule is provided by either constitution or private law to govern a decision In such cases the courts must seek their principles from other fields of law, particularly private law and international law, depending upon the subject matter of the controversy and the position in which the states appear Thus, ordinary rules of private law may govern a transfer of personalty between states, but would be wholly inadequate to settle title to boundaries of territorial jurisdiction

In the United States, Canada, and Australia, the Supreme Court or High Court, as the case may be, is vested with general jurisdiction over suits between member states, in slightly different terms in each instance, but sufficiently broadly to include all categories of cases which are brought by state against state [5]

[4] This principle is forcefully presented by Josef L Kunz in "Une Nouvelle Théorie de l'état fédéral," *Revue de droit international et de législation comparée*, 3me ser, XI (1931) 868; and in his *Die Staatenverbindungen, Handbuch des Völkerrechts* (Stuttgart, 1929), Bd II, Abt 4 Though the language of the courts implies the application of international law directly in a suit between member states, the juridical consequences of such statements do not appear to have been considered. If the competence of a member state derives directly from international law, then it is not subordinate to the constitutional norms If, however, the very existence of the state is a product of constitutional procedure, international law can be only indirectly applicable by the adoption of certain of its principles into municipal law

[5] United States Constitution, Article III, Section 2, Commonwealth of Australia Constitution Act, Articles 75, 76 The British North America Act, 1867, Article 101, has been interpreted to authorize the establishment by statute of a Supreme Court and Exchequer Court with jurisdiction over actions between provinces

In Germany and Switzerland, however, certain cases, including those that involve territorial jurisdiction, are known as suits at public law, as distinguished from civil suits Under the Swiss Constitution of 1848 cases at public law came before the Swiss Federal Council with provision for appeal to the Federal Assembly[6] The German Constitution of 1871 vested this jurisdiction in the Bundesrat, where the cases were generally delegated to a judicial court for settlement[7] The records of public-law cases between states in both countries during these periods are incomplete and difficult of access[8] By Article 113 of the Swiss Constitution of 1874 cases in public law were placed under the jurisdiction of the Federal Tribunal, except for a few cases of an administrative nature Under Article 19 of the Weimar Constitution of 1919 a Staatsgerichtshof was established, with jurisdiction over all suits between the German states or between Reich and states

A large majority of disputes between member states of federations have arisen out of questions of territorial jurisdiction (*Gebietshoheit*) These partake clearly of the nature of international disputes, whether the state claims actual ownership or merely rights of jurisdiction The international-law rules of jurisdiction are fairly well established, consequently, in this sphere analogies to international-law rules prove to be peculiarly close

It is the purpose here to examine the law applied to one problem of territorial jurisdiction, that of boundaries, as it has arisen in suits in five federations, three of which, the United States, Canada, and Australia, rely on the common law, while two, Germany under the Empire and the Republic and Switzerland, have legal systems based on Continental law Care must be observed in drawing generalizations that they are not too broad, that constitutional differences are not overlooked in substantive law and in the jurisdiction of the courts which may be determining factors in individual decisions[9]

[6] Article 74 [7] Article 76

[8] The reports of the decisions of the German Bundesrat seem never to have been published, except for those of one or two individual cases See *Annalen des Deutschen Reichs*, 1877, p 993, and a list of decisions in Seydel, Max von, *Kommentar zur Verfassungs-Urkunde für das Deutsche Reich* (Leipzig, 1897), pp 406–407 A partial collection of Swiss decisions is available in Ullmer, R. E, *Die staatsrechtliche Praxis der schweizerischen Bundesbehorden, 1848–1863* (2 vols, Zurich, 1864, 1866)

[9] For the purposes of this paper only a few important interstate cases have been used. A more complete discussion of individual United States and Swiss

Neither constitution nor private law in any federation provides a ready-made rule for such controversies But, given the jurisdiction, the court does not refuse to hear and decide the case The judicial task is to find law compatible with the federal legal system and with the nature of the dispute and of the parties, whether the state comes before the court to demand *dominium* or *imperium*, as holder of an ordinary property right or as sovereign appearing as *parens patriae* to protect the rights of its citizens To do less than this would be to renounce the function of a court [10]

Boundary disputes between member states existed in the earliest federations From the records of the Greek federations Raeder has collected numerous examples of frontier controversies which were settled by the judicial method of arbitration [11] Unfortunately, no information has survived on the principles of law which guided these boundary delimitations In modern federal states disputes between member states concerning boundaries are very common In the United States no less than forty-two boundary cases have come before the Supreme Court since 1789 In the other federations only a few boundaries have been the subject of judicial dispute, but many settlements and adjustments have been made, as between independent states, by treaty, compact, or less formal mutual agreement

The settlement of a boundary involving jurisdiction over a disputed territory is generally held not to involve an alienation or cession To this point the United States Supreme Court has said

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cases will be found in Scott, *op cit*, and in Schindler, Dietrich, "The Administration of Justice in the Swiss Federal Court in Intercantonal Disputes," 15 *Am Journ. Internat Law* 149–188 (1921)

[10] In Switzerland, if the dispute is a matter of private law, Article 2 of the Swiss code of civil law prescribes that the judge shall "decide according to the rule which he would establish if he were a legislator" The Federal Court does not follow this principle, however, in disputes in public law between cantons, and has in several cases allowed the conflict of cantonal sovereignties to continue, on the ground that cantonal sovereignty is unlimited in this respect, or that no rules of federal law exist which permit an equitable solution *Entscheidungen des schweizerischen Bundesgerichtes* (cited hereafter as *E S B*), 29, I, p 450; 5, p 426, 7, p 468; 24, I, p 227 German jurists seem to have interpreted Article 4 of the 1919 Constitution making international law a part of German law as directing the rules of decision in those cases where no federal law exists Once over the hurdle of jurisdiction in *Rhode Island* v *Massachusetts* (see *supra*, p 625), the Supreme Court of the United States has never questioned the fact that a rule would be found and a decision given in every case

[11] Raeder, A , *L'Arbitrage international chez les Hellènes* (Kristiania, 1912).

It [this decision] involves neither a cession of territory nor the exercise of political jurisdiction In settling the rights of the respective parties, we do nothing more than ascertain the true boundary, and the territory up to that line on either side necessarily falls within the proper jurisdiction [12]

An action brought by the State of South Australia against the State of Victoria claimed an error in the surveyed boundary of 1855 which deprived the plaintiff of a strip of territory two and a quarter miles wide, along the length of the western boundary [13] The pleading was phrased as an action of ejectment, seeking possession and mesne profits on the area The plea was rejected by the court, which held that the ascertainment and acceptance of the boundary line was in the nature of an award or judgment *in rem*, binding on the states and all persons claiming under them, and, so regarded, it could not be an alienation of territory Higgins, J , dissented on the ground that the error could be remedied by the court where remedy would lie for a private person, but not in this case, since the state was not owner of the land, and was also out of possession [14]

Unless a clear grant or title exists to the contrary, it must be presumed that possession, long held and acquiesced in, confirms the right of a state to ownership and jurisdiction The rational basis for such acquisitive prescription in international law is the creation of stability and order [15] When one state is in peaceful and undisturbed possession of an area, and protest from other claimants has not been raised over a long period of time, the conviction prevails that the present condition of things is in conformity with international order, and should be confirmed Nor does possession in international law have to be originally rightful as in *usucapion* in Roman law. Possession originally *mala fide* may be confirmed by lapse of time and acquiescence.[16] It is an imperative presumption of the federal system that stability and order be upheld, that the exercise of

[12] McLean, J , in *Rhode Island* v *Massachusetts*, 4 Howard 591, 628 (1846)

[13] *South Australia* v. *Victoria*, 12 C L R 667 (1911); [1914] A C 283

[14] 12 C L.R 667, 742

[15] Oppenheim, L , *International Law*, 5th ed , ed Lauterpacht (2 vols , New York, 1935, 1937), Vol I, Sections 242–243

[16] Though *bona fide* possession is not so necessary in international as in domestic law, it is not to be disregarded. In an award of 1933 on a boundary conflict between Guatemala and Honduras the tribunal stated that one question was whether the possession of one of the parties had been rightfully acquired and without violating the rights of the other party. *Opinions and Awards of the Special Boundary Tribunal, Guatemala and Honduras* (Washington, D C , 1933), p 70

criminal and civil jurisdiction over a boundary area should not be subject to change to another state which has never claimed to exercise the rights and duties of possession and government over it Though generally prescription is not held to overcome a clear title in another state the courts will hold a disputed boundary long acquiesced in, although possibly in error, as correct This is especially true of astronomical boundaries run and determined by authorized commissioners and afterwards found to be inaccurately located To this point the Supreme Court said in *Virginia* v *Tennessee*·

> A boundary line between States or Provinces, as between private persons, which has been run out, located and marked upon the earth, and afterwards recognized and acquiesced in by the parties for a long course of years, is conclusive, even if it be ascertained that it varies somewhat from the courses given in the original grant, and the line so established takes effect, not as an alienation of territory, but as a definition of the true and ancient boundary [17]

This doctrine of prescription and acquiescence has been criticized in its application to Australia and Canada, where a state is not empowered to give up territory by agreement, and therefore may not do so by acquiescence At the same time the logic of its applicability to the quasi-sovereign states of the American union was recognized [18] An excellent statement was made on the applicability of prescription to American states in a suit between Michigan and Wisconsin over correction of the boundary in Green Bay after nearly a century of acquiescence in Wisconsin's full possession and jurisdiction

> That rights of the character here claimed may be acquired on the one hand and lost on the other by open, long-continued and uninterrupted possession of territory, is a doctrine not confined to individuals but applicable to sovereign nations as well, *Direct U S Cable Co* v *Anglo-American Telegraph Co*, [1877] L R 2 A C 394, 421, . and, a fortiori, to the quasi-sovereign states of the Union The rule, long-settled and never doubted by this court, is that long acquiescence by one state in the possession of territory by another and in the exercise of sovereignty and dominion over it is conclusive of the latter's title and rightful authority [19]

The period required to lapse in order to confirm a prescriptive title is by no means clear from decisions of the courts In one case it was suggested that the length of time necessary to raise a right of prescription in private parties likewise raises such a presumption in

[17] 148 U S. 503, 522 (1893), citing Lord Hardwicke in *Penn* v *Lord Baltimore*, 1 Vesey Sen. 444, 448.

[18] Higgins, J, dissenting in *South Australia* v. *Victoria*, 12 C L R 667, 742 (1911).

[19] *Michigan* v. *Wisconsin*, 270 U S. 295, 308 (1926)

favor of states, in another, that nearly one hundred years of acquiescence in possession should not be disturbed, and in a Swiss case, that a period of one hundred and fifty years should be conclusive [20] Probably none of these is the answer The time must be determined according to the facts of the individual case, and would seemingly depend principally upon the coming into existence of important private rights that would be disturbed by the change

Where a boundary has been long acquiesced in by a predecessor in title, the successor state is bound to that line This was the situation in respect to the boundaries of New Mexico with Colorado and Texas, which had been long recognized by the United States before the territory was admitted as a state into the Union [21]

In 1925 Lübeck brought an action against Mecklenburg-Schwerin in regard to the rights of sovereignty and of fishery, in particular in a part of the Bay of Lübeck which was territorial waters of the defendant state Plaintiff based its claim on exercise of the rights of jurisdiction over fisheries in the area since the sixteenth century and regulation of them by a law enacted in 1896 which defendant must be presumed to have known After granting a provisional order in favor of Lübeck in light of her long undisturbed possession,[22] the Staatsgerichtshof examined fully the law applicable to the case In 1928 a final judgment divided sovereignty over the bay functionally, the regulation of fisheries going to Lübeck "This immemorial possession justifies the presumption of its legality as well as the attribution to Lübeck of these rights for the future " [23] Mecklenburg-Schwerin also alleged acquiescence of Lübeck authorities in certain

[20] *Maryland* v *West Virginia*, 217 U S 577, 579 (1910), *Indiana* v *Kentucky*, 136 U S 479, 518 (1890), *Zurich* v *Schaffhausen*, 1894, *E S B*, 33, I, p 594

[21] *New Mexico* v *Colorado*, 267 U S 30 (1925), *New Mexico* v *Texas*, 275 U S. 279 (1927) Similarly, *Missouri* v *Iowa*, 7 Howard 660 (1849)

[22] *Lübeck* v *Mecklenburg-Schwerin*, Provisional Order of the Staatsgerichtshof, 10 October 1925, Entscheidungen des Reichsgerichts in Zivilsachen (cited hereafter as R G Z), Vol 111, Appendix, p 21, *Annual Digest*, 1925–1926, Case No 85, 15 *Juristische Wochenschrift* 376 (1926)

[23] *Lübeck* v *Mecklenburg-Schwerin*, 1928, R G Z , Vol 122, Appendix, p 1 The tribunal pointed out that several different adjustments could be made each state could be given sovereignty over a portion of the bay, or both states could enjoy exercise of joint and indivisible sovereignty over the whole bay, or, without falling under the full sovereignty of either state, the bay could partake of the nature of a maritime belt However, historical development and actual needs of the states are decisive, and in this instance justified a functional division, the regulation of only fisheries and navigation going to Lübeck It is submitted

of her claims to preserve the shores of the bay The court ruled that no single act of a Lübeck authority could create international rights in favor of Mecklenburg-Schwerin if none had existed before "Conduct, to be creative of international custom, must be regular and repeated; it must emanate from the competent authorities of the state, and it can create rights only as between states between which it took place"

The Swiss Federal Tribunal has been more conservative in its application of the principle of acquisitive prescription than have the courts of the other federations In a suit between Zurich and Schaffhausen in 1907 the plaintiff canton failed to prove its claim to exercise jurisdiction over the whole of the Rhine in a portion of the common boundary upon the basis of either *usucapion* or immemorial prescription [24] The tribunal stated that the *usucapion* of Roman law as known in the German law of the Middle Ages (the period when the right in question was supposed to have arisen) was merely applied in the negative sense of excluding the right of contest by a rightful owner against an unrightful acquirer after a lapse of a number of years, thirty being the maximum within which such an acquisition might be contested However, immemorial prescription was admitted, but was found not to apply in this case The court defined prescription as "a legal foundation for a lawful exercise of right since the memory of man, that is, eighty to one hundred years, and . actually uncontested" [25] Similarly a claim that one canton had exercised police duty in a disputed territory was held to be decisive only if it had been effected with the full knowledge of the other claimant canton [26] However, the court will confirm a bound-

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that this is by no means an established principle of international law, but particularly suited to individual property relations and to the close relations between states of a federal system The general rule on division of boundary lakes and bays is to follow either the *thalweg* or, if there be no main navigable channel, a middle line *Louisiana* v *Mississippi*, 202 U S 1 (1906), *Minnesota* v *Wisconsin*, 252 U S 273 (1920); *New Jersey* v *Delaware*, 291 U S 361 (1934); *Wisconsin* v *Michigan*, 295 U S 455 (1935), Bolle, Arnold, *Das interkantonale Recht* (Châteaux-les-Fonds, 1907), p 43

[24] *Zurich* v *Schaffhausen*, 1907, *E S.B.*, 33, I, p 537. [25] *Ibid*, p 594

[26] *Graubünden* v *Tessin*, 1892, *E S B*, 18, pp 673, 688 To the same effect, in *Zurich* v *Schaffhausen*, 1897, *E.S B*, 23, II, p 1459, the plaintiffs had granted concessions for waterworks on a portion of the Rhine claimed by the defendant. The court held that such limited acts of encroachment on cantonal sovereignty, although tolerated, are not sufficient to be treated as evidence of a tacitly effected modification of the boundary.

ary line accepted traditionally for more than a century and a half by popular opinion and the authorities of the two cantons concerned.[27]

If a boundary river is not navigable, the imaginary line as a rule runs down the middle of the river, equidistant from the banks and following all turnings of the border line of both banks of the river This rule, laid down by Grotius and endorsed by Vattel, was modified at the beginning of the nineteenth century by substituting, in dealing with navigable rivers, the middle of the main ship channel or *thalweg* [28] These principles are based upon a recognition of an equality of right, on the part of the riparian states, of access to and use of the waters of the stream In the United States a large proportion of boundary rivers are navigable, and the Supreme Court has uniformly applied the *thalweg* principle, except when the terms of a grant or treaty, or equity, require the court to follow a different boundary line [29] Where there are two or more important channels in a river, as is true of the Columbia River between Washington and Oregon, the court has ruled that a change in their importance by gradual filling of one channel would not act to change the original boundary designated as "the middle of the north channel" [30] In accordance with a principle recognized in Roman law, a gradual change in the main channel by accretion will carry the boundary with it in the main channel, but an avulsion or sudden change in the course of the river does not result in the boundary following the new *thalweg* It remains in the center of the former main channel of navigation [31] Islands which change sides of the river through a shift in the *thalweg* by avulsion remain under the jurisdiction of the same state as before the change [32]

All these claims, it should be noted, are subordinate to a right established by prescription and acquiescence This was the issue involved in a decision of the Supreme Court in 1940 in *Arkansas* v *Tennessee* Chief Justice Hughes, speaking for the court, said.

The rule of the *thalweg* rests upon equitable considerations and is intended to safeguard to each State equality of access and right of navigation in the stream

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[27] *Appenzell-ausser-Rhoden* v *St Gall*, 1895, *E S B*, 21, p 957

[28] Oppenheim, *op cit*, I 415–416; Hyde, Charles Cheney, *International Law* (2 vols ; Boston, 1922), I 242–249

[29] *Iowa* v *Illinois*, 147 U S 1 (1893); *Louisiana* v *Mississippi*, 202 U S 1 (1906); *Handly's Lessee* v *Anthony*, 5 Wheaton 374 (1820)

[30] *Washington* v *Oregon*, 211 U S 127 (1908)

[31] *Arkansas* v *Tennessee*, 246 U S 158 (1918)

[32] *Missouri* v *Kentucky*, 11 Wallace 395 (1870)

The rule yields to the doctrine that a boundary is unaltered by an avulsion and in such case, in the absence of prescription, the boundary no longer follows the *thalweg* but remains at the original line although now on dry land because the old channel has filled up And, in turn, the doctrine as to the effect of an avulsion may become inapplicable when it is established that there has been acquiescence in a long-continued and uninterrupted assertion of dominion and jurisdiction over a given area [33]

The same principle has been applied in the United States to bays and gulfs to delimit offshore jurisdiction of two adjoining states [34] However, if there is no clear navigable channel and commerce may ply over most of the lake or bay, the principle of equality of right demands the drawing of a boundary equidistant from the shores rather than a crooked line connecting points of greatest depth [35] Similarly, where free navigation for both states has been guaranteed in a boundary-river convention, the purpose of the *thalweg* rule is lacking, and the boundary follows the middle of the river [36] It will not be altered by an artificial straightening of the channel

The rivers of Switzerland are nonnavigable, and the boundary has regularly followed the middle of the river, unless, as frequently happens, definite grants, treaties, or early arbitration decisions give jurisdiction over the whole river to one of the riparian states [37] Thus, in a suit between Zurich and Schaffhausen, the defendant canton was given sovereignty over the entire Rhine in a certain sector in accord with a Confederate award of 1555 [38]

Where the bed of a boundary river is made a part of the territory of one of the boundary states, the line will extend at least along low-water mark on the opposite side of the river [39] This is to be measured at the ordinary water level, not in periods of spring flood or great drought If the designation reads the "banks" of the river, the line will be drawn at the point where well-defined banks are evident or where the vegetation ceases [40]

[33] 310 U.S 563, 571 (1940)

[34] *Minnesota* v *Wisconsin*, 252 U S 273, 282 (1920)

[35] *Louisiana* v *Mississippi*, 202 U S 1 (1906), *New Jersey* v *Delaware*, 291 U S 361 (1934)

[36] *Georgia* v *South Carolina*, 257 U S 516 (1922)

[37] *Zurich* v *Schaffhausen*, 1907, *E S B* , 33, I, p 537.

[38] *Schaffhausen* v *Zurich*, 1897, *E S B* , 23, II, p 1405

[39] *Handly's Lessee* v *Anthony*, 5 Wheaton 374 (1820), *Indiana* v *Kentucky*, 136 U S 479 (1890); *Vermont* v *New Hampshire*, 289 U.S 593 (1934)

[40] *Alabama* v *Georgia*, 23 Howard 505 (1859); *Oklahoma* v *Texas*, 260 U.S. 606 (1923)

In determining a boundary on land or water the primary duty of the court is to follow the boundary defined in the constitution, treaty, or federal law, if this can be clearly ascertained, and not to determine what the boundary ought to be on equitable principles [41] Where the terms are obscure the court will endeavor to determine the original intent of those who defined the boundary, by an examination of contemporary documents and historical materials and according to the memory and eye-witness accounts of old settlers and from maps The Privy Council was aware in the Labrador boundary dispute that too great weight should not be given to official maps of the claimant state drawn since its claim had been set up A map may be made a part of a treaty, but an error in locating natural features on the map upon which a boundary is based will not prevent the court from correcting the line when the true location of the river or mountain is ascertained [42]

Natural boundaries along a mountain chain or watershed are accepted in international law unless altered by treaty or prescription [43] The Judicial Committee applied the principle of the line of the watershed in determining the Labrador boundary between Newfoundland and Canada in absence of any more reasonable criteria to be found in the acts setting up governing jurisdiction over the coast [44] On the other hand, the Swiss Tribunal in *Appenzell-ausser-Rhoden* v *St Gall*, 1895, rejected the peak of the Säntis as a boundary in the face of a showing of long recognition of a boundary extending over that peak.

It is clear that in the present case we can not primarily take the natural topography into consideration, but that we must rather attach a preponderating importance to the exercise of sovereign acts, to traditional possession, etc In fact, deviations of the political boundary from the natural one frequently occur Particularly in mountainous regions deviations of the political boundary occur from the water sheds [45]

Although not directly raised between states, a more recent problem of boundary jurisdiction involving international law has

[41] Viscount Cave *In re Labrador Boundary*, 1927, Privy Council, 43 T L.R. 293

[42] *United States* v *Texas*, 162 U S 1 (1896)

[43] Oppenheim, *op cit.*, I: 417 A claim to territory based on occupation may be held to extend to the sources of all rivers emptying within that coast Moore, John Bassett, *A Digest of International Law* (8 vols , Washington, 1906), I · 263

[44] *Re Labrador Boundary*, 43 T L R. 289.

[45] *E.S B* , 21, pp 957, 972

resulted from the claims of certain American states to jurisdiction in the open sea beyond the traditionally recognized three-mile limit of territorial waters Though the United States adheres to the three-mile limit, Louisiana, Alabama, and Mississippi were admitted to the Union with boundaries designated as three, six, and six leagues, respectively, offshore [46] The Louisiana legislature in 1938 passed an act extending the jurisdiction of that state twenty-four miles into the sea beyond the three-mile limit [47] The purpose of the act was "to declare the sovereignty of Louisiana along its seacoast and to fix its present seacoast boundary and ownership " Further, full sovereignty was claimed over the waters, beds, and shores of the Gulf within these boundaries The reason for this and similar legislation proposed in other coastal states is the wish to gain control of and assert the state's ownership in the sea bottom should oil be discovered there

It is settled in the United States that the marginal sea is an integral part of the state, subject to the right of innocent passage, and that the state can define its boundaries on the sea within what are generally recognized as territorial limits of states by the law of nations [48] A conviction has been had under the Florida law of 1917 regulating the taking of sponges to a distance of ten miles offshore [49] Claims of property in the ocean floor have been made and successfully asserted in several instances, such as that of the twenty-mile area of pearl banks off the coast of Ceylon [50] These rights seem to have been acquired by occupation and use and confirmed by acqui-

[46] 2 Stat 701, judicially recognized in *Louisiana* v. *Mississippi*, 202 U S 1 (1906), 3 Stat 348, 3 Stat 489. Also, Florida's Constitution of 1868, setting a maritime limit of three leagues, was accepted by Congress when that state's representatives were readmitted after the Civil War 15 Stat 73

[47] *Louisiana General Statutes* (1938), No 55

[48] *Manchester* v. *Massachusetts*, 139 U S 240 (1890), Oppenheim, *op cit*, 4th ed, ed McNair (2 vols; New York, 1928), I, Section 1906

[49] *Pope et al* v *Blanton et al*, 10 F Supp 18 (1935), but cause remanded with directions to dismiss for want of statutory jurisdiction, 299 U S 521 (1937) The Florida Constitution, accepted by Congress when Florida representatives were readmitted in 1868, set a three-league limit for territorial waters In *Skiriotes* v *State*, 197 So 736 (1940), the state Supreme Court held that it was a reserved right of sovereignty for a state to extend its boundary beyond one marine league, and that nothing in the law of nations forbade it The Supreme Court of the United States evaded the territorial issue and settled the case on the basis of the personal relationship between sovereign and subject *Lambiris Skiriotes* v *State of Florida*, United States Supreme Court, 1941 Term, No 658, L Ed, Advance Sheets, p 824

[50] Oppenheim, *op cit* (see note 15), I·494 n

escence If the bed of the sea beyond the three-mile limit is *res nullius* as some have claimed, it should be subject to this effective physical possession

The three-mile limit, chosen because it was the approximate range of a cannon shot in 1702, is seriously open to question today,[51] and is frequently circumvented by setting up wider zones, such as the one hour's sailing distance in the liquor treaties and special customs'-enforcement zones [52] However, while the United States Government asserts as against other nations a three-mile limit on the closed sea, the assertion of right to twenty-seven miles by a member state may well prove a source of embarrassment There seems no reasonable basis for believing that the three-mile belt of waters which surrounds the United States suddenly widens to nine miles off the coast of Florida It is equally unreasonable to maintain that one of the states exists with part of its territory beyond the boundaries of the Union This also raises the question whether or not a state by acquiring territory independently can enlarge the territory of the United States Could the state enforce its jurisdiction against a citizen of a foreign country who drills for oil in the bed of her territorial sea? The implications of this problem are far-reaching

It is quite evident that there is a marked uniformity among the different federations and different legal systems on the basic principles of law which shall guide boundary settlements, and that these all conform closely to generally accepted principles of international law, which in turn have been markedly influenced by Roman-law concepts Preëminent weight is given in each case to the terms of an original grant in treaty, charter, or constitution, the methods of weighing evidence to discover the intent being similar to those used in most courts of law, domestic or international Acquisitive pre-

[51] See Bingham, Joseph Walter, *Report on the International Law of Pacific Coastal Fisheries* (Stanford, 1938), Fraser, Henry S , "The Extent and Delimitation of Territorial Waters," 11 *Cornell Law Quarterly* 458 (1925–26)

[52] Since 1790 the United States has enforced a customs' administration zone extending twelve miles outward from the coast Treaties providing for seizure of vessels smuggling intoxicating liquors within one hour's sailing distance from shore were negotiated with sixteen nations in the 1920's The Anti-smuggling Act of 1935 empowered the President to proclaim a customs' enforcement zone as far as sixty-two miles from the coast Public Act No 238, 74th Congress, 1935, Hearings before the Committee on Ways and Means, House of Representatives, on H R 5496, 74th Congress, 1st session, 1935, Jessup, Philip C , "The Anti-smuggling Act of 1935," 31 *Am Journ Internat Law* 101–105 (1937)

scription and long acquiescence is generally recognized as a strong determining principle of ownership, although the period, the sufficiency of evidence, and the weight given to it is somewhat more restricted in Swiss law than in the law of the other federations, where the international-law standard for the rule of prescription has been adopted. The courts in all federations will resort to international law when it provides an applicable rule and they will adopt that rule into interstate law, modifying its application when necessary to achieve substantial equity. The court of no federal state has set itself up as a tribunal to dispense equity apart from law, but the flexibility of rules of law has generally permitted the equity demanded by sound jurisprudence Finally, the very substantial contributions of positive practice which federal courts are adding to this phase of international jurisprudence should prove a step in the direction of international order under law

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THE REACTION TO SOCIALISM IN AMERICAN PROTESTANTISM, 1880–1900

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SOCIALISM had long been a familiar feature of the American scene,[1] but the impact of alien and more aggressive philosophies, in the eighties, aroused Protestants as to something novel Socialist and anarchist agitation reinforced the concern evoked by the developing "trust" movement, the growth and increased vigor of labor organizations, and the first evidences of the "new" immigration[2] The great railroad strikes of 1886 and the Haymarket Square bomb explosion in the same year were events too portentous to be lightly regarded

But the socialism upon which Protestant churchmen bent their gaze in the eighties was not clear-cut or definitive *Das Kapital* did not have an English translation until 1887, it was to be much later before it would become the "Bible" of socialists and the fount of "party-line" orthodoxy[3] Gronlund's *Co-operative Commonwealth in Its Outlines*, the English translation of de Laveleye's *Socialism of To-day*, and John Rae's *Contemporary Socialism*, which appeared together in 1884,[4] were more widely read and accepted by Protestants than was Marx.

One of the earliest expressions of Protestant opinion came from the Reverend T Edwin Brown, pastor of the First Baptist Church at Providence, Rhode Island. In 1886 the Reverend Mr Brown published a volume of public addresses on issues of the day under

[1] See the many religious communistic communities and the early vogue of Fourierist and Owenite theories, as described by Fred E. Haynes in *Social Politics in the United States* (Boston, 1924), pp 22–42

[2] Latta, Maurice C, "The Background for the Social Gospel in American Protestantism," *Church History*, 5 (1936) 256–270

[3] *The Encyclopedia of the Social Sciences*, Vol X (New York, 1935), pp 172–173

[4] Gronlund, Laurence, *The Co-operative Commonwealth in Its Outlines* (Boston, 1884); de Laveleye, Émile, *Socialism of To-day* (London, 1884), Rae, John, *Contemporary Socialism* (London, 1884).

the title *Studies in Modern Socialism and Labor Problems* Seven of the fourteen chapters dealt with socialism, in these the author presented in popular form and fairly sympathetic manner a summary of the socialist position as he saw it The socialists begin, according to Mr Brown, by claiming that the Industrial Revolution brought only suffering where it should have brought happiness, and that modern workingmen are "wage-slaves," to whom their employers acknowledge no responsibility beyond the payment of wages "Free contract," he writes, "between employed and employer is a delusion The freedom is all on one side It is the freedom to buy in the cheapest market without a corresponding right to sell in the dearest market The supply of labor is more than the demand" The author then goes on to state the socialist claim that the profits of the capitalist are "fleecings" (the term used by Gronlund), and to present the socialist denunciation of the press, the pulpit, and the bar as accomplices of the capitalist robbers The economic theory of socialism, that "Labor is the foundation of all value" and that "the produce of labor constitutes the natural recompense of labor," he finds to be derived from Adam Smith, "without regarding any of the explanations and qualifications of the statements, even those which Smith himself made" Capital, by virtue of its "fleecings" from labor, and through the operation of the "iron law of wages," is said to be enhancing its position, with the result, in socialist claims at any rate, that the rich are growing richer while the poor are growing poorer and more numerous and the middle class is tending to disappear [5]

Brown's analysis was clear, but his presentation of the positive program was not so well done He attempted to define two schools of socialists, the "Anarchist-Socialists," who would reorganize society on the basis of autonomous "communes and townships," with equal pay for equal time spent in labor, and with money to be abolished and replaced by "labor-notes," and the "Labor-Socialists," whose program, as he described it, was condensed almost wholly from Gronlund [6] Clearer pictures of socialist aims were, however, soon drafted,[7] and a vehement and wide-ranging debate followed

[5] *Studies in Modern Socialism and Labor Problems* (New York, 1886), pp 31–43

[6] *Ibid*, pp 47–56

[7] See the address by David Jayne Hill, President of Lewisburg (Bucknell) University, Lewisburg, Pennsylvania, published in *The Baptist Congress for the*

There was some disposition, which was encouraged by various socialist writers,[8] to welcome socialism as "sprung from Christianity"[9] But this tendency, whether among socialists or churchmen, was not typical, and came in for sharp condemnation Henry van Dyke wrote, with heavy sarcasm, of "the communistic doctrine" which

. of late years has laid aside the red cap and put on the white cravat It quotes Scripture, and claims to be the friend, the near relative, of Christianity So altered is its aspect that preachers of religion are discovering that it has good points, and patting it on the back — somewhat timidly, as one might pat a converted wolf who had offered his services as a watch-dog[10]

Even friendly observers referred to the "atheistical and materialistic" nature of "current socialism"[11] and recognized sharp lines of cleavage between Christianity and socialism

At this distance the nature of the distinctions as the churchmen developed them is somewhat surprising The antinomy most widely accepted by the clergy was a reflection of the tendency to regard the socialist goal as a rigid autocracy, organized upon doctrinaire principles After two decades of debate Washington Gladden summarized these objections as follows

I have read many arguments to prove that individuality could be properly conserved and developed under a regime of common property — a regime in which individual enterprise was practically forbidden — but they have not convinced me I am as sure as I can be of anything which has not been fully demonstrated by experience that the extinction of private enterprise — the complete nationalization of all forms of industry — would result in a distinct reduction in the intellectual and moral force of the people[12]

Gladden's testimony is weighty, not only for his own position, but also as a very valuable guide to prevailing ideas He was not

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Discussion of Current Questions (hereafter cited as *The Baptist Congress*) (New York), 4th Session (1886), p 24, Andrews, E B, "Socialism," *Hartford Seminary Record*, 4 (1894) 132; Bliss, W D P, *A Handbook of Socialism* (London, 1895), p 1

[8] Cf a passage from de Laveleye quoted by Washington Gladden in "Christian Socialism," *National Congregational Council, Minutes* (1889), p 341

[9] Bliss, *op cit*, p viii

[10] "Christianity and Communism," *Forum*, 4 (1887) 299

[11] Moxom, P S, pastor of the First Baptist Church, Boston, as reported in *The Baptist Congress*, 5th Session (1886), pp 42–43, *Andover Review*, 12 (1889) 210–212.

[12] *Christianity and Socialism* (New York, 1905), p 125

original, but tended in his writings and in his conclusions to reflect, very faithfully, the ideas of others There is abundant evidence, moreover, that Gladden was here in the main stream of Protestant opinion The *Christian Register*, for example, charged bluntly that "State socialism is a conspiracy not only to destroy individualism, but individuality as well" [13] The Episcopalian *Churchman* echoed the charge with the added declaration that "this is essentially opposed to the Christianity of Christ" [14]

Independent of any conception or misconception of the socialist program, Protestant churchmen in this period put a high value upon individualism E B Andrews but voiced a common attitude when he said "Personal liberty and the opportunity for untrammeled individual development are the best products of civilization Any proposition toward social change which jeopardizes these will, and deservedly, sink of its own weight, however much promise of mere animal comfort it may have to recommend it" [15] Appealing to history, George Willis Cooke declared

> In so far as the modern world is superior to the ancient world, the superiority is due to the growth of individualism Socialism is simply a "survival in culture" It is an attempt to realize at the present day what the whole of modern history has condemned All the progress which the world has made during the last 2000 years has been the result of growth away from the methods and the principles of socialism [16]

An outspoken Congregational layman, who was by no means unfriendly to the social movement in religion, maintained "If we lose sight of individualism, we shall have again the unsolvable problem of how to make a social paradise out of individual sinners, how to create a perfect whole out of imperfect units" [17]

The emphasis thus indicated upon the intrinsic value of individuality is certainly central to Christian standards, and not necessarily alien to socialist ones But the churchmen tended to go beyond these arguments for individuality and to make claims which are not so certainly referable to Christian ideas, but which smell more of the nineteenth-century market place Passing from his appeal to history, for example, Cooke went on to declare "We

[13] *The Christian Register*, 72 (November 23, 1893) · 737
[14] *The Churchman*, 75 (January 23, 1897) · 113
[15] "Socialism," *Hartford Seminary Record*, 4 (1894) . 130
[16] "Socialism in the Light of History," *Andover Review*, 14 (1890) . 249
[17] Holbrook, Z Swift, "Civic Reform," *Bibliotheca Sacra*, 55 (1898) 132.

can never do away with the stimulus of individual motive or the energizing power of personal necessity."[18] The *Churchman* was positive that, "If Socialism were realized, it would merely mean the death and dissolution of society. Society without the effort and competition of individuals would result in a recurrence to barbarism."[19] Miss Vida Scudder, no enemy of social reform or of a social emphasis in religion, predicted harshly that, in a socialistic society, "People will no longer be forced to work by the stringent fear of starvation; thus they will not work at all. We shall end by producing a race of dead-beats ... virtue, as we now conceive it, will cease to exist. Courage, endurance, industry — the militant instincts — will have no room to play in."[20]

Such ideas are understandable in the light of a conception of socialism which could refer to "the slavery of this socialistic theory, according to which the Government was to wake up private citizens in the morning, dress them and make them say their prayers, trot them round during the day, and at night put them to bed, and then take away the candle."[21] But even a grotesque misrepresentation of socialism is not enough to explain the strange phenomenon of the Christian commentator accepting the idea of selfish individualism as a necessary element in society. When we recall that the Church had been immersed for centuries in a society whose prevailing social temper had been a glorification of aggressive, even ruthless, individualism, it is not surprising that some voices among the churchmen echoed the ideas of their environment and denounced an ill-understood socialism for menacing those egoistic wellsprings of individual activity which they had been taught to regard as the glory of their age and country. But the influence of the social environment will not alone account for the uneasiness with which the leaders of Protestant thought observed the potentialities of socialism. The type of character favored by American Puritanism — the shrewd, ambitious, hard-working, responsible, self-denying individualist — had not arisen out of the simple compulsion of need, greed, and ambition. Puritanism had contributed its portion to the making of that character, although there is no agreement as to the weight

[18] *Op. cit.*, p. 253.

[19] *The Churchman*, 75 (1897): 8.

[20] "Socialism and Spiritual Progress — a Speculation," *Andover Review*, 16 (1891): 51.

[21] Wayland, H. L., as quoted in *The Baptist Congress*, 4th Session (1886), p. 29.

of its influence[22] Yet now, in an age when the drama of the soul before its God (a Calvinistic concept) had lost its tremendous fascination and could no longer afford vital force to ethical precepts, those simple egocentric elements, need, greed, and ambition, combined with social tradition, might be relied upon to conserve that favored type of character But what of the future if this new scheme of socialism should become operative? Could the Puritan character survive — its ideal world in ruins at the feet of triumphant science and democracy — if society should come to condemn self-regarding motives and egoistic achievement?

In their attitude toward individualism the churchmen were not wholly consistent They rejected an immoral individualism in economics,[23] yet they were prompt to defend the values of individuality against the presumed perils of socialism A few persons were violent in their opinions, but the most capable spokesmen for religion took a middle position Gladden, for example, explained socialism as the reaction against "unsocialism," or extreme individualism He regarded scientific socialism as extravagant in its program of restrictions upon personal property and liberty, but he recognized the excesses of individualism as affording a justification for this attitude "Individualism," he wrote whimsically, "was a good club wherewith to fight feudalism, it is a bad cornerstone whereon to rear society "[24] Lyman Abbott declared bluntly that "individualism is the characteristic of simple barbarism, not of republican civilization "[25] An obvious basis for a moral reconciliation with socialism was afforded by one writer with the remark "When the law is 'Every man for himself,' the Devil gets the foremost as well as the hindmost "[26]

What the churchmen wanted was a society in which "the Devil"

[22] The works of Tawney, Troeltsch, Weber, and Sombart are concerned primarily with the Puritan in Europe For especial attention to American Puritanism see, among others, Luccock, Halford E , *Jesus and the American Mind* (New York, 1930), Chap III

[23] Latta, Maurice C , "The Thought of Protestant Churchmen concerning Social and Economic Problems, 1890–1914" (MS, Ph D dissertation, Ohio State University Library, Columbus, Ohio, 1930), pp 206–219

[24] "Socialism and Unsocialism," *Forum*, 3 (1887) · 124

[25] This opinion was written in 1865 and reprinted, as still his own, in his *Reminiscences* (Boston, 1915), p 440

[26] Chalmers, Andrew, "The Growing Socialism," *Bibliotheca Sacra*, 59 (1902) 257

would have slim pickings, and they feared that socialism might undercut the foundations of Puritan character and restrict opportunity for moral development As Gladden put it in a vigorous early attack upon socialism "The Bible asserts and defends the freedom of every man, it suffers no invasion of his personality, it clears wide spaces all about him, and cries aloud to tyrants, hierarchs, demagogues, 'Stand aside! Give this man room to work out his own salvation'" [27]

Not that the Protestant theologues had much confidence in the men for whose freedom they were contending They were not yet humanists, although some of them might be on the way toward that extremist's bourn To be sure, they were beginning to develop a "social gospel" which was ultimately to have as one of its premises the need of a Christian society for the living of a Christian life, yet there was, before 1900, little or no support in the churches for the idea that reform alone would be enough Socialism, wrote Brown, "would seek to change character by changing condition, instead of changing condition by changing character Here is the root fallacy of the Socialist's demand" [28] Even the radical George D Herron subscribed to this position with the declaration "A wrong social system can be succeeded by a just social order only through a right social spirit, we cannot have the order first and then the spirit, the just order must be the fruit of the spirit" [29]

The churchmen, although critical of the excesses of selfish individualism, were bound to look with a pessimistic eye upon any plans for building a new social order with "the old man" They believed that the old society functioned, even if creakingly, because personal need and other egoistic motives drove men to work But could a society be expected to prosper where such motives no longer operated? Gladden, for example, held that there were too many malingerers and idlers in society for socialism to succeed [30] Social malingering he apparently regarded as something inherent in human nature. Yet he thought it possible to teach men to "put love into their work if we only teach them that every honest work ought to be a labor of love," and he looked forward to the day "when we

[27] Published in the *Magazine of Christian Literature* (New York) for January, 1891, and quoted in *The Literary Digest*, 2 (January 10, 1891) 287

[28] *Op. cit*, p 85

[29] "Social Regeneration," *Charities Review*, 4 (1895) 293

[30] *Christianity and Socialism*, pp 111–112.

shall have here upon the earth a real chivalry of labor, workers of all ranks and callings who love to work not merely for the stipend, but also for the joy of service "[31] But the tone of his comments is skeptical rather than confident, and in this, as in other things, Gladden was in harmony with his contemporaries Pessimism with regard to human nature was definitely stronger and more apparent before 1900 than it has been since that date L P Jacks, in full rapport with the Christian sentiment of *his* day, could write in 1928 of making the sense of trusteeship or "the high traditions" of a possible social service the basic and dynamic factors of a new society,[32] but such optimism would have been unacceptable to Protestants before 1900

Someone might well inquire into the reasons for this difference The obvious answer would seem to be that Jacks is a generation further than Gladden from a time when the doctrines of Original Sin and Total Depravity had been accepted without reservation But obvious answers are sometimes disconcertingly wrong It would be interesting at any rate to inquire whether the growth in Protestant confidence has anything to do with the philosophy of Royce, with Stanley Hall's studies in morale, and with the promise of progressive politics

The churchmen before 1900 could still entertain low conceptions of human nature David Jayne Hill, for example, in the course of an attack upon socialism, argued that invention, artistic achievement, even the services of the pulpit — "imagine yourselves preaching your fifty-dollar sermons for seven time-dollars a week" — would fail under the socialist scheme, which he assumed would entail equality of rewards[33] (Here is a lower order of economic determinism than any that Marx posited)

But the churchmen saw themselves as aiming at a different goal than the socialists "The Socialist," wrote Lyman Abbott, "puts improvement of condition first, both in time and in importance, and the Christian disciple puts the improvement of character first, both in time and in importance "[34] An attempt to exploit this divergence as a basis either for alliance or indifference may have

[31] *Christianity and Socialism*, pp. 174, 175
[32] *Constructive Citizenship* (Garden City, 1928), pp 99–100, 174–183
[33] Reported in *The Baptist Congress*, 4th Session (1886), p 26
[34] "What Is Christianity?" *Arena*, 3 (1890) 40

underlain the extremist editorial of the *Churchman* which declared, "Socialism, properly so called, has nothing to do with moral relations It is solely and purely a matter of economics, and ultimately of politics But Christianity has got nothing whatever to do with economics or politics excepting so far as they concern the moral attitude of the individual."[35] This was far enough for Dr van Dyke, who proclaimed

> a fundamental and absolute difference between the doctrine of the Bible and the doctrine of the communizer For the Bible tells me that I must deal my bread to the hungry, while the communizer tells the hungry that he may take it for himself, and if he begins with bread there is no reason why he should draw the line at cake The Bible teaches that envy is a sin, the communizer declares that it is the new virtue which is to regenerate society The communizer maintains that every man who is born has a right to live, but the Bible says that if a man will not work neither shall he eat, and without eating life is difficult[36]

This passage of Dr van Dyke's comes closer to an explicit attack upon the doctrine of the class war than any other found The most surprising feature of the Protestant reaction is the silence on this point Neither the class war nor economic determinism was the subject of any vigorous attack by clerical critics In the beginning the silence was probably due to the prevalence of non-Marxian forms of socialism, although the American Protestant tendency toward activism rather than philosophic speculation doubtless operated in the same direction The synthesizing tendencies which were so strong before the War led the churchmen to stress the moderate and reformist aspects of American socialism[37]

Lack of concern for the doctrine of the class war is the more surprising in view of the sharply expressed repugnance of Protestants for the use of force in labor disputes[38] For explanation of this discrepancy we must again fall back upon the nonspeculative ten-

[35] *The Churchman*, 55 (1897) 113

[36] *Op. cit*, pp 304–305 See also Peabody, F G, "Colonization as a Remedy for City Poverty," *Forum*, 17 (1894) · 61; Gladden, *Christianity and Socialism*, p 51.

[37] See the Preface to the 1914 reprint of Gladden's *Christianity and Socialism*, Chamberlin, Harrie R, of Morgantown, West Virginia, as reported in *The Baptist Congress*, 27th Session (1909), p 49

[38] See, for example, Bachelor, George, "The Revolt of the Majority," *Forum*, 1 (1886) · 516–517; Wheeler, A S, "The Labor Question," *Andover Review*, 6 (1886) : 478; MacVicar, D H, "Social Discontent," *Presbyterian Review*, 8 (1887) 262–281

dencies of Protestant thought, tendencies which were reinforced in the generation after 1880 by a gathering aversion to the doctrinal elements in Christianity [39]

In summary, then, the early reaction of American Protestants to socialism appears not so much hostile as alarmist In the light of evangelical conceptions of the nature of man the theologues questioned the possibility of a new society without new men, and they feared the effects which might result from a collectivist order — ill-understood by most of them — upon the Puritan character The philosophical elements of socialist thought meant little either way The much more emphatic reactions to other elements of the contemporary scene make it clear that, in the two decades from 1880 to 1900 at any rate, socialism did not seem very significant to the articulate elements of American Protestantism

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[39] See Harris, George, *A Century's Change in Religion* (Boston, 1914), pp 41 *et seq*, Gladden, *Recollections* (Boston, 1909), pp 220–225, Abbott, *Silhouettes of My Contemporaries* (Garden City, 1922), pp 213–214; Mathews, Shailer, "The Awakening of American Protestantism," *Constructive Quarterly*, 1 (1913) 102–115, *Christian Register*, 75 (1896) 33

LANGUAGE AND LITERATURE

THE LIBERALISM OF PÍO BAROJA

NELSON W. EDDY

IT HAS long been tacitly assumed as fact that Pío Baroja, the most genuinely popular member of Spain's so-called "generation of '98," may be correctly referred to as a liberal. Baroja's identification of his own cherished attitudes with "un liberalismo extremo"[1] has confirmed the appropriateness of the term.

Recently, however, his liberalism has been mooted in a critical study contrasting the attitudes of Baroja and Ricardo León.[2] The writer of the study, Mr. John T. Reid, very properly begins by attempting to arrive at a satisfactory working definition of "liberalism." The *Encyclopaedia Britannica* is first consulted and yields the following description:

> Liberalism is a belief in the value of human personality, and a conviction that the source of all progress lies in the free exercise of individual energy; it produces an eagerness to emancipate all individuals or groups so that they may freely exercise their powers, so far as this can be done without injury to others; and it therefore involves a readiness to use the power of the State for the purposes of creating the conditions within which individual energy can thrive, of preventing all abuses of power, of affording to every citizen the means of acquiring mastery of his own capacities, and of establishing a real equality of opportunity for all. These aims are compatible with a very active policy of social reorganization, involving a great enlargement of the functions of the State. They are not compatible with Socialism, which, strictly interpreted, would banish free individual initiative and responsibility from the economic sphere."[3]

This definition, though unfocused in time, has the high virtue, I believe, of indicating the general objectives underlying any specific application of the term "liberalism."

Mr. Reid next traces the particular directions taken by liberal movements since Francis Bacon, especially during the nineteenth and twentieth centuries. He then appraises Baroja, chiefly with reference to modern trends, and finds his liberalism doubtful. Those

[1] *Rapsodias* (Madrid, 1936), p. 54.

[2] Reid, John T., *Modern Spain and Liberalism, a Study in Literary Contrasts* (Palo Alto, Calif.: Stanford University Press, 1937).

[3] *Encyclopaedia Britannica*, 14th ed. (1929), XIII: 1000a (under "Liberal Party").

of his views which would bar him from the ranks of the liberals, in Mr Reid's opinion, are numerous, and some of them basic

For example, Baroja is temperamentally cynical regarding the theory of *progress*, the great liberalizing shibboleth of the nineteenth century, and he questions the validity of *reason* as a dependable guide for mankind, thereby going counter to the philosophical direction given liberalism by the eighteenth-century French rationalists He disbelieves in the democratic theory of government, and in republicanism, at least as concerns Spain In the recent war in Spain his position was somewhat ambiguous

To this indictment against Baroja's liberalism, as drawn by Mr Reid, may be added an intense theoretical dislike of the Jew — evident in every work of Baroja — and a contempt for Latin Americans — a prejudice based on the representatives of the Western Hemisphere who travel in Europe, for Baroja has never crossed the Atlantic [4] With these illiberal attitudes, which would appear to align Baroja with fascistic or extreme nationalistic elements in Spain, may be contrasted his alleged disdain for the bourgeoisie,[5] a logical corollary of his inclination toward Tolstoyan anarchism

In considering a novelist who is so intricately enmeshed in the ideological strife of our times, and who has confessed to several deep-seated prejudices, it might well be feared that his human portraits would be mutilated or distorted Has Baroja the artist transcended Baroja the theorizer and critic?

It is undoubtedly true that the most memorable and most sympathetically drawn characters in Baroja's world are social misfits, who are lacking in enthusiasm for the same points of view as Baroja himself disdains His happiest creation is probably the famous Silvestre Paradox [6] So close a kinship does Baroja feel with this eccentric inventor and scientist that he has even made his birth date the same as his own, December 28, *día de inocentes.* Aviraneta of the *Memorias* series, Elizabide the vagabond, Pachi the cemetery caretaker who raises cabbages, the old cynic Tellagorri,[7] "hombre de

[4] See the study by Troconis, Gabriel Porras, "Un escritor español contra los americanos," *Cuba Contemporánea*, 16 . 352–356 1918

[5] See the study by Castro, Cristóbal de, "Galería de contemporáneos Pío Baroja o el burgués antiburgués," *La Esfera*, 12, No 577 1925

[6] See the highly illuminating essay by Aníbal, Claude E , *Paradox, Rey* (New York, 1937), pp xxxiv–xl and *passim*

[7] See the early chapters of *Zalacaín el aventurero* (Madrid, 1909).

mala fama y de buen corazón," the more sophisticated frustrate José Larrañaga,[8] Andrés the unhappy student of medicine,[9] all these supreme creations in Baroja's gallery are the victims of social maladjustment — comic, pathetic, occasionally heroic

The particular prejudices which might most seriously distort Baroja's view of mankind and result in the delineation of absurd grotesques are his alleged antibourgeois sentiment, his dislike for Spanish Americans, and his assured anticlericalism [10] and anti-Semitism

The first of these attitudes, revealed by frequent strictures against bourgeois narrowness and stupidity, is less fundamental and positive than Baroja's other illiberal biases In the very earliest of his longer works, *La casa de Aizgorri* (1900), the figure of Mariano, the well-to-do owner of a foundry, rises to heroic proportions at the end of the somber drama Mariano is rich, industrious, "un hombre honrado," and genuinely considerate of women — for which latter trait he is roundly berated by an *hidalgo* of the old school Physically, he is "un hombre alto, de barba castaña, espesa, un poco cargado de espaldas Tiene la mirada apagada, la nariz corva, la sonrisa amable y triste" He is joyfully welcomed by a friend's dog, which Baroja obviously regards as a favorable sign [11] The picture is prepossessing, but not idealized

If it be objected that *La casa de Aizgorri* is rhapsodical drama in the grand manner and not typical of Baroja, let us consider the work by which he is best known generally, the famous "Struggle-for-Life" trilogy (1904), with its murky background of slum life in Madrid, against which socialists and anarchists debate Here the person who holds together the domestic life of the unheroic hero, Manuel, until he shall have sown his intellectual and amatory wild oats, is the girl called *la Salvadora*, one of the most winning of Baroja's women She is tolerant of human weaknesses, but is unmistakably a homemaker, who wants a family and a good garden She is the embodiment of all the bourgeois virtues, yet so pervasive is her charm

[8] Protagonist of the trilogy *Agonías de nuestro tiempo* (Madrid, 1926)

[9] Hero of *El árbol de la ciencia* (Madrid, 1911)

[10] Baroja's anticlericalism has not been mentioned earlier, among the author's *illiberal* views, because Mr Reid, whose path I have been closely following thus far, correctly regards it as a token of Baroja's *liberalism*, in the technical historic Spanish sense

[11] See *La casa de Aizgorri* (Madrid, 1920 ed.), pp 37–40, for these descriptive details

and quiet strength of character that when Manuel returns from the funeral of his martyred brother, who died an apostle of anarchism, one feels that a peaceful and normally happy life awaits him with *la Salvadora,* whom he has shortly before married. Indeed the whole third volume of the trilogy (*Aurora roja*) shows Manuel himself gradually settling down into a reasonably quiet life as a mechanic and *burgués,* as he is referred to by himself and by his friends, and as such becoming a steadying influence on his brother and the latter's associates. When the hurly-burly of this monumental work of poverty, criminality, and radical reprisals has died away, the homespun qualities of a *petit bourgeois* are discovered to have been given an adequate and just — though not glowing — representation.

This attitude of fairness toward the individuals of a class which, as a Tolstoyan anarchist, Baroja has often enough fulminated against in the abstract, continues into the years following the establishment of the Republic of 1931. In *Los visionarios* (1932) the points of view and the constituency of the farm-labor cooperative groups supporting the Republic and holding their meetings in the *Casas del pueblo* are observed through the eyes of three automobile travelers, whose opinions are quite evidently those of the author. While human and broad in sympathy, these opinions are middle-of-the-road, bourgeois. This is not surprising, in view of Baroja's equivocal position in the civil war to follow, but it is worth remarking that they are not essentially different from the ideas expressed by Manuel in the trilogy written during the most turbulent and rebellious days of Baroja's career.

Before we leave this section, an example of artistic integrity should be mentioned in regard to a character figuring in one of the most moving scenes from Baroja's latter-day novels. This character is a *marqués,* a member of a decadent aristocracy severely arraigned by Baroja in a work [12] written as recently as two years before the novel in question.

He is indistinguishable from any wealthy bourgeois, and when first encountered is described as of "gusto torpe y vulgar," [13] a phrase

[12] See *Los visionarios* (Madrid, 1932), p. 15. "A la Monarquía le ha pasado como a la aristocracia. no se legitimaba socialmente por nada. No sabían dar normas de humanidad ni siquiera de elegancia. El monarca y el aristócrata cobraban sus rentas, las gastaban o las guardaban y no daban nada en espíritu o en gracia o en formas a la colectividad. Se van pues buen viaje."

[13] See *Las noches del Buen Retiro* (Madrid, 1934), p. 204.

one might expect from Baroja, who, however, counterbalances it with "Entre los amigos se le consideraba alegre, ocurrente y original."[14] After a period of cruel neglect, the Marquis' beautiful wife, Concha, finds a measure of solace and understanding in the company of Jaime Thierry, a brilliant but erratic bohemian journalist, who falls madly in love with her. Not having heard from Concha for some time, Jaime resolves to visit her at her husband's country estate. From a certain distance he beholds Concha in the garden, peacefully sewing in the company of her two children and their nursemaid. Realizing that all is over between them, Jaime steals back unobserved to the road. While he is brooding there, with his head resting in his hands, the Marquis appears. Jaime is prepared to be truculently defiant, but the Marquis invites him to return and talk with Concha and himself. When the invitation is refused, the Marquis offers him his carriage to the railroad station and ends by removing his own topcoat and placing it on Jaime's back, lest he get chilled, giving him at the same time a friendly pat on the shoulder and telling him he is a "buen muchacho." Jaime is so affected by this unexpected kindness that he somewhat brusquely leaves the Marquis, for fear the tears in his eyes will be noticed.[15] The scene between the two men is handled with the utmost naturalness and sensitiveness — and yet the central figure is a member of a breed despised by Baroja, the Spanish plutocracy.

Concerning Baroja's hostility toward Spanish Americans, I am afraid nothing can be offered to show the artist in him transcending the prejudiced thinker. The Argentine visitors from America are viewed from a distance and superficially, in cafés and salons, where they commonly conduct themselves (in Baroja's novels) in a presumptuous, arrogant, and generally disagreeable manner.[16]

One concludes that Baroja has never known a Spanish American sufficiently well to afford him materials for the execution of a really intimate portrait.

[14] *Ibid.*, p. 209. [15] For this scene see *ibid.*, pp. 300–302.

[16] Baroja's dislike of *americanitos* has persisted through the years with scarcely diluted acidity, as the following comment from *Vitrina pintoresca* (Madrid, 1935), p. 251, will show: "En esta última época han venido a mi casa tres o cuatro americanitos con adulaciones y sonrisas y luego ha visto uno que han escrito algo contra mí con ese fondo de mala voluntad un poco ruin que hay en la mayoría de los escritores hispanoamericanos. A mí no me importa mucho que hablen mal de mí, pero leer un insulto y recordar una sonrisa no es muy grato; da una impresión triste del hombre."

The true touchstone of the ability of the Spanish novelist to rise as artist above the prejudices of the theorist, will be his treatment of priests and their associates, and of Jews, since for these two groups, in the abstract, he nourishes a deep-seated aversion Be it conceded at once that a considerable number of smug, ignorant, or evil priests are allowed a place in Baroja's *tertulias* and briefly appear in his boardinghouses and at the council tables of corrupt politicians and the meanly rich. Such clerics represent their class, as Baroja views it, and their appearance is not prepossessing It is also true that glimpses are caught now and again of priests who are a credit to their office and to the human race.[17]

As one is brought nearer, however, and becomes more and more conscious of the priest as a man, one may discover anything, as with any other human being To begin with, we are told that Aviraneta, to whose liberal machinations Baroja has devoted some twenty-three volumes (the number may still grow!), "no era de los anticlericales que tienen antipatía personal por los curas, al revés, se entendía bien con ellos Gondraondo [párroco de la anteiglesia de Gatica, en Vizcaya] era hombre amable y servicial, un tanto satisfecho de sí mismo, como buen vizcaíno Aviraneta y Gondraondo se hicieron amigos Pasearon juntos," etc [18] There are many Gondraondos scattered through the *Memorias* series, and the reader comes to know some of them very well

A good example of Baroja's seemingly instinctive tendency to balance the good and the bad, among priests as among other classes of people, is found in the story "La Canóniga" [19] Sansirgue, a cathedral *penitenciario*, is a hard, pushing, double-dealing individual, whose treacheries eventually bring about his own discredit and violent death He is matched, however, as a representative of the cloth, by Don Victor, a chaplain of nuns, who plays an upright and intelligently humane rôle in the book As times become more troubled, Don Victor joins the forces of the Carlists,[20] a politico-religious faction which Baroja deplores because of its reactionary brutalities,

[17] For example, the Augustinians met on a boat in *La estrella del capitán Chimista* (Madrid, 1930), pp 219 ff ; in the same passage praise is accorded the work of certain Franciscans in the Philippines and in Japan.

[18] *Con la pluma y con el sable* (Madrid, 1915), p 20

[19] This story is included in Volume V of the *Memorias*, a volume entitled *Los recursos de la astucia* (Madrid, 1915), pp 5–162 It has also been published separately (Madrid, n. d).

[20] *Ibid.* (1915), p 161

but the Carlist-to-be receives fair treatment from the author, and in fact emerges as the one positively honorable character of the story He is "estudioso y listo hombre inteligente, trabajador, austero "[21]

On the other hand, Rafael del Riego, the famous liberal leader and defender of the Constitution of Cádiz against the tyrannical usurpations of Ferdinand VII, the man to whom the most fiery of Spanish revolutionary songs is dedicated, under Baroja's touch appears more human than godlike. "Riego tenía aire febril," announces Baroja's report He received Aviraneta coldly, as if fearing the latter might diminish his own prestige and glory The two men agreed in the solutions to their problems, but were in disaccord in the motives which impelled them, "este desacuerdo en los motivos fundamentales," remarks Baroja, "es el que produce casi siempre mayor falta de estimación entre las personas" Aviraneta was audacious by instinct, Riego by reflection; what was easy and spontaneous for the one, required an effort from the other Riego was an incomplete hero, Aviraneta a perfect adventurer. Since Riego aspired to the complete control of the liberal movement of 1820 he both feared and despised Aviraneta The latter in his turn thought "This poor fellow [Riego] wants to be a hero and hasn't the energy for it "[22] Baroja follows this description with an account of Riego's campaign, which he represents as a series of actions badly conceived and faultily executed, but by some miracle successful in its immediate objectives

This is not muckraking It does, however, draw Riego down to Spanish earth from the clouds of legend which enfold him In its way it explains, with reference to Riego's mentality, why his victory was only partial, and why Spanish liberalism, under such auspices, did not endure beyond 1823

An example of the focusing of Baroja's telescope on an individual from the opposing camp, that of the ultra-Catholic and illiberal Carlists, is afforded in his handling of the Conde de España and the latter's activities in 1838 This sinister individual remains a "tipo bárbaro, sanguinario y humorista";[23] Baroja does not essay to whitewash the black sheep. But at the conclusion of Baroja's wrestling

[21] *Ibid*, p 81

[22] See *Con la pluma y con el sable*, pp. 46–49

[23] See *Humano enigma* (Madrid, 1928), p 230.

with the enigma of the Count's complex personality, an inhuman and incredible monster has been reduced to human and credible proportions It is difficult to show by citation how this result has been achieved, for it follows from a slowly cumulative process, beginning with the Count's first appearance in the company of two young officers Everyone scurries for shelter except the unsuspecting English visitor to Spain, he meets the Count face to face and salutes him, and his salute is civilly returned [24]

The development of the Count in human colors continues, through conversations and actions Baroja shows him as sardonically amused by his own rôle in history, that of a Spaniard and a fanatic, when he is actually a Frenchman, of the lineage of Comminges and Foix, and, in part, a skeptic ("incrédulo") [25] The multitude is viewed by the Count as an amorphous conglomerate to be dominated and led, it is most impressed, he contends, by displays of arbitrary injustice giving the impression of something "fatal y determinado," like a blind but irresistible force of nature — and he can cite in support of his contention episodes from the lives of men enthroned as popular heroes [26] The ability to lie, or to act a part, is a necessary concomitant of an eminent public figure, as of a general. A leader of the masses who is not a histrion, is nothing [27] The populace responds, not to a complex thought, which may be in part contradictory, but to a phrase, a slogan, a shout, something very simple and very elemental [28]

With such Machiavellian doctrines as his gospel, the Count's violent career in the later 1830's is at least explained, while no part of it is denied Here again, as with the ideologically opposed Riego, a credible and psychologically satisfying likeness has been drawn from a towering myth by the artist, Baroja, who has selected his materials now from the left wing, again from the right, of Spanish political life. It would be impossible to decide, from these two characterizations, on which side the sympathies of the writer himself lie.

As a last check on Baroja's ability to concentrate his attention and his imagination on the essential human soul which lies behind a visible exterior, let us see if he has been able to lay aside his oft-

[24] *Humano enigma*, pp 104–105.
[25] *Ibid*, pp 307–308.
[26] *Ibid*, pp 311–312
[27] *Ibid*, p. 314.
[28] *Ibid.*, p. 315

proclaimed blanket hostility toward Hebrews. Jews have been discouraged for centuries, by official fiat and popular feeling, from making their home in Spain. Jewish blood remains in the peninsula, to be sure, and it reveals itself, in Baroja's novels having a Spanish setting, in sundry hawk-nosed figures skulking in the background shadows, waiting to pounce upon some poor unfortunate in need of money. One might say the unsavory figures are conventional, traditional. Baroja's anti-Semitism is thus a part of the pattern of his works, a sort of embroidery or fringe.

In the novels having a foreign setting, however, the reader is introduced to some authentic Jewish people. In most of these Baroja maintains that balance of good and bad attributes which has already been remarked. Abraham Tick and his son Will, and old Israels, who are all connected with the printing and bookselling business in London, are not paragons of virtue, but neither are they blackguards.[29] "Israels era un judío," we read, "de unos sesenta años, de ojos claros, nariz cortante y perilla blanca. Tenía una amabilidad excesiva y una mirada burlona."[30] The excessive amiability is a disagreeable trait, but the "mirada burlona" is a Barojan stamp of approval. Here, as in most of the novelist's creations, Jew or gentile, there is a mixture of qualities, but humor predominates, and if the venerable Israels is something of a rascal, at least the reader is encouraged by Baroja to smile tolerantly at the old sinner's wiles.

But from a few sketches of Jewish character a warm glow emanates. The most intimate and detailed picture of Jewish family life which I recall from Baroja's novels presents a widow and her four daughters in Tangiers.[31] Aviraneta had taken lodgings with this family, and became well acquainted with them all. The girls and their mother are *bordadoras*, and are diligent workers, thrifty, and excellent housekeepers. The girls are attractive, and their relations with their gentile friends provide the plot interest. A fine good will prevails throughout the story. Incidentally, the family all speak Spanish.

The most attractive individual delineation of its kind to be found

[29] See the story called "El viaje sin objeto," in the volume *La ruta del aventurero* (Madrid, 1916). These characters appear on pp. 168 ff.

[30] *Ibid.*, p. 171.

[31] See the story "El niño de Basa," in the volume *Los contrastes de la vida* (Madrid, 1934; volume first published in 1920; this story written in 1917), pp. 71–99.

in Baroja's novels is, I believe, that of Jonas Pinhas (= Peña), an old Spanish Jew who owns a small fish shop ("Los Tres Peces") in London [32] This characterization represents one of those felicitous moments in which Baroja is unsurpassed in modern Spanish literature So congenial does Baroja find Jonas, that he afflicts him with rheumatism, in honor of his own sufferings from arthritis — a sure token of the author's esteem [33] The old fellow, innocently wishing to impress his visitors, boasts of his youthful acquaintance with taverns where regicides and other revolutionary crimes had been hatched; but he doesn't at all fool a little Russian girl who has been listening, for, says Baroja "La pequeña Macha debió de notar que aquel patriarca era un buen sujeto, porque sin ceremonia alguna se le subió a las piernas y le tiró de las barbas" The little girl then has the patriarchal revolutionist lift her in his arms, so she may investigate a stuffed alligator suspended from the ceiling, and the old man next shows her the accomplishments of an impudent frog he has in his aquarium Remarks Baroja "Macha había presenciado estas maniobras con profunda admiración El viejo Jonás reía a carcajadas" [34] Surely Jonas' race has not here prevented Baroja from creating one of his warmly rich and mellow portraits

It is probably not mere coincidence that Baroja's most attractive Hebrews speak Spanish but reside outside Spain It must be true that the novelist has been drawn toward such types in his travels, because of the tie of language, and has been at some pains to cultivate their friendship His really authoritative intimate impressions of Jewish character may well have been formed in alien lands

From the survey above, and from other examples which could be adduced, it may be said that Baroja's close-up characterizations are not drawn to support a theory, whether the theory be dubbed liberal or illiberal Nor have more personal prejudices against middle-class and aristocratic stupidities, or against Jews and Catholic priests, diverted his artist's brush from depicting plausible and psychologically interesting figures I believe the following passage from *Los visio-*

[32] See *La ciudad de la niebla* (Madrid, 1909), pp. 171–179, especially p 177

[33] Even the monumental Aviraneta of the *Memorias*, the man of action, suffers from this affliction Aviraneta's hair also thins early in life — and Baroja's total baldness is well known!

[34] *La ciudad de la niebla*, pp 177, 179

narios, with its examples, fairly shows Baroja's inveterate dissatisfaction with the inadequacy of conventional tags or classifications·

There is always an obscure part in persons, even in those who appear most diaphanous, which it is almost impossible to apprehend Very often, in reading biographies of men famous for their talent, their energy, or their crimes, we discover that the implacable politician, the terrible, bloodthirsty general, the terrorist police chief was a timid man who raised canaries, played with cats at home, was kind to children, and would weep when he heard a shepherd boy playing the flute in the fields Were their violence and their cruelty a tactic? Were their instincts upset in action? We do not know [88]

There then follows in this same passage an assertion that the characteristic trait of Alfonso XIII, the runaway king, is his timidity, at which the first speaker — a doctor, like Baroja himself — comments "It seems that one has said something quite definitive in qualifying a man as timid, but it is possible that very little has been said Timidity may proceed from a weakness of the will or from some strong inhibition" To which it is objected that, in practice, the results will be the same, and the doctor retorts "But for the psychologist the mechanism will be totally different"

I believe the hypothesis is tenable that this almost clinical interest in the *mechanism* of the human mind, an interest of a romantic guided and restrained by the special knowledge of one trained in medical theory and practice, has provided the really vital marrow for Baroja's creatures of human flesh and blood The question of the writer's liberalism, while tremendously interesting, in the last analysis depends for its answer upon the choice of definition In terms of contemporary attitudes and procedures commonly called liberal, the answer is debatable — might well be in the negative In more general or universal terms, such as the "belief in the value of human personality," a decision as to the worth human personality possesses for one who has spent his life endeavoring to understand and describe it with such justice and magnanimity as we have seen could not be open to question

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[88] This passage, and those immediately following, are my translations from *Los visionarios*, p 17.

A CONTRIBUTION TO THE GENESIS OF SPATIAL CONCEPTS EXPRESSED BY ADVERBS AND ADJECTIVES

CLARENCE L MEADER AND HIDE HELEN SHOHARA

THIS paper, which attempts to explain the rise of spatial concepts by correlating the development of the sensory and motor apparatus with the functions involved in the appreciation of spatial relationships, is based on the following facts commonly accepted by competent authorities

1 The evolution of the body and mind proceed from general undifferentiated masses of tissue and perceptions to more specific and more highly differentiated (individualized) forms (Child, 1924, Berry, 1928, Coghill, 1929a, 1929b, Lashley, 1930, and others) This is illustrated in language (*a*) by the development of the vocabulary of infant and child from the one-word sentence, in which the entire thought is summed up in a single word that is neither noun, verb, adjective, or adverb,[1] to the highly elaborate many-word sentence (Stern, 1907, Piaget, 1926, Shirley, 1931–33, Lewis, 1936, and others), and (*b*) by the contrast between the cruder forms of gesture language, which even the lower animals use to some extent, and the more highly refined forms of human speech

2 The organs of the human body develop in the same order in all normal individuals, although at rates varying with the individual

3. Movement and the perception of movement are fundamental prerequisites for the adjustment of the body in space and for the appreciation of spatial relationships

The child's first usage of particular words should not be confused with its earliest perceptions of the ideas which they express There

[1] As used in this paper a noun (substantive) is a symbol of an organized group of relatively permanent qualities, a verb, a symbol of such a group of transitory qualities, an adjective, a symbol of one of these permanent qualities, and an adverb, a symbol of a transitory one

is abundant evidence in the child's movements and its inarticulate cries that it has recognized the difference between moving and stationary objects and has become aware of certain qualities of objects before it learns their names The present paper is concerned with the development of ideas (meaning)

It describes briefly the earlier stages in the development of certain bodily structures The functioning of these structures is essential to the production of spatial ideas, which are linguistically symbolized for the most part by formative elements, adjectives and adverbs or adjectival and adverbial phrases, although they are also associated with other parts of speech Actually, all the organs of the human body take part in this emergent process, but in the interest of simplicity this paper treats mainly the structure most directly involved, namely, the nervous and muscular systems

All organs and their functions arise in the same systematic spatial and temporal order in all individuals The development begins in the region of the mouth, and proceeds from this point in both directions, that is, toward the feet and toward the top of the cranium It starts in the prenatal period and continues until maturity We are concerned only with its earlier stages [2]

Language (commonly regarded as a product of the mind conceived as an entity by itself) is, in both its phonetic and semantic forms, like the mind, an emergence of the functioning tissues (muscles, glands, nervous system, etc) The correlating structures of the brain are wholly dependent upon the sense organs for the material which they correlate. The stimuli to which the sense organs respond are in turn determined, in large part, by the moving muscles

In what order now do the organs essential to the learning of spatial relationships develop in the child?

The neuromuscular structures of the head, trunk, and limbs are well represented and the muscles are capable of movement in the tenth week of the prenatal life. The movements, however, are weak, diffuse, of small amplitude, and, often, jerky. A stimulus to a single point on the body may lead to widespread muscular response, and the same or similar diffuse response may be elicited by stimulations over a wide area. This means that the neuromuscular system is

[2] For the anatomical and physiological data we are indebted to Feldman (1920), Minkowski (1922), Herrick (1932, 1938), Langworthy (1933), and many others.

in the primitive condition of nonspecificity and noncoördination, in which, even if consciousness were present, only crude localization could be recognized, corresponding to such vague adverbs as "somewhere" This is the stage of so-called "neurological" functioning, "done unconsciously or at least without clear-cut realization of ends and means" (Herrick, 1938) However, these acts, even though unconsciously performed, contribute to the development of specificity, since they play a part in the establishment of future more permanent structures and functions (habits) attended by consciousness From now on the development, like all other evolutionary processes, consists in the rise of more specific characteristics We must bear in mind that with each successive step in the emergence of physiological activities there arises a correspondingly complex and specific type of meaning

The following are the principal ways by which this greater differentiation is brought about

1 By the development of more specific types of muscular contraction through the stages of increasing precision tonus, tonicity, tetany, contracture, and simple contraction

2 By increase in size of the muscle, which continues to grow until maturity This means greater working energy and greater amplitude of movement Such growth has an important influence on our conceptions of size We have all been surprised on visiting scenes of our childhood in later years to notice how small old familiar objects have become Size of structure and amplitude of movements are the yardstick by which we measure objects, but unlike a wooden yardstick it grows continually larger

3 By an increased number of muscle cells, which make possible a higher degree of differentiation in the amount of contraction of the muscle as a whole This is brought about by the establishment of a peculiar type of nerve supply (the so-called "all-or-nothing" system)

4 By the vestibular (balancing) apparatus of the ear and its nervous connections with the extrinsic muscles of the eyeballs, with the cerebellum, and, through the cerebellum, with the muscles of the body

5 By the development of the sensory organs of movement (muscle spindles and the modified nerve endings in tendons and joints), than which none play a more fundamental part in determining the meanings of adverbs of size, shape, and place, and the learning

of language Hewer (1935) demonstrated the presence of muscle spindles in practically all the organs of the body, including the extrinsic muscles of the tongue and the external eye muscles, in the four-month fetus Since the motor nerves along with the commissural and longitudinal connecting nerves in the spinal cord and medulla are already present, the anatomical basis has now been laid for simple reflex action and the automatic repetition of reflexes without which tradition in language would be impossible

6 By the formation of a fatty, protecting, and, probably, also insulating sheath, known as the myelin sheath, about the nerve fibers This sheath prevents, at least in some measure, the diffusion of the nerve impulse, and so aids in the establishment of greater specificity of action The completion of myelination is generally taken as a sign that the nerve is capable of functioning normally

7 By the perfecting of the apparatus for accommodation and focusing of the eyes, necessary especially to the discrimination of distance not attainable by reaching and touching

8 By the perfecting of the auditory mechanism

9 By coördination of muscular activity Practically every bodily activity is performed not by a single muscle but by the integrated action of many muscles To secure harmony of movement, a whole series of structures develops during the growing period These mechanisms, in the order of their increasing complexity and specificity, are

(*a*) The simple automatic reflex arrangements in the spinal cord.

(*b*) The medulla, coördinator of chiefly vegetative processes and the region of lowest instance for production of speech movements

(*c*) The cerebellum, the reflex and unconscious motor coördinator, equilibrator, and regulator of the orientation in space of the head, body, arms, and legs.

(*d*) The midbrain, concerned chiefly with automatic reflexes of sight and hearing.

(*e*) The thalamus, which adds sensory and emotional elements and intensifies the sensations

(*f*) The striate body, which regulates chiefly more elaborate, automatic associated movements.

(*g*) The cerebral hemispheres, which supplement all this with a more detailed analysis and a fully voluntary control over extremely delicate and widely varying movements

Each of these muscle-nerve gradients brings about a pattern of nervous, muscular, and mental action more complex and more highly differentiated than the preceding, and each thereby enriches the meanings of words, renders sharper and more precise our spatial vocabulary, and makes possible our traditional highly abstract grammatical categories

Owing to the rapid structural changes incident to growth and differentiation in the prenatal period, as well as to the somewhat restricted variety of stimuli received from the mother and from changes in the fetus itself, it must be assumed that previous to birth there are few habitual patterns of movement established which coincide with or even closely resemble those that occur in postnatal life Exceptions must be made of the heartbeat and the balancing movements The latter are very common, since the child floats freely in the amniotic fluid In spite of the absence of a substratum, many of these movements must contain elements closely resembling those of postnatal life

The conditions are radically changed at birth, since the gross bodily structure has already been attained, and a whole world of new stimuli begin to impinge upon the child's sensory apparatus The postural muscles continue after birth to play a dominating part in the child's development, in the sense that all the more specific movements, the more accurate and delicate adjustments of walking, reaching, and grasping, as well as highly refined skilled movements, including the adjustments of the eyes and touch, must be made in conformity with the momentary position of the body (cf Kempf, 1935) Consequently they vary as that position varies

The postural apparatus is functioning at birth as far as the vestibular apparatus and kinesthesis are concerned, but the muscles are so small and weak that the child can do little more than turn its head from side to side, wave its arms in a stereotyped manner, and move its legs a little First the muscles of the neck gain sufficient strength to lift the head from the pillow, though it is still wobbly when the child is held in a sitting position. Next the arm muscles and the back muscles develop to the point that the child can sit alone It is due to the gradual perfection of the postural muscles that the child is able first to hold up its head (eight weeks), tries to sit up (twelve weeks), sits alone (thirteen weeks), gets up on hands and knees (eight months), creeps (ten months), walks with support

(eleven months), walks alone (one year) With the gradual strengthening of these muscles and their corresponding reflexes, the structural basis for the development of the spatial concepts is steadily improved It is destined, however, to be further refined by the development of the eyes, ears, and tactual organs and of the complicated connections of the anterior brain stem and the cerebral cortex

The ears are deaf, or at least hear very imperfectly, at birth, and the eyes are far from mature They are too close together, and their axes are directed inward, so that at rest they are converged upon near objects The lens of the eyes has a very strong refraction index, and the eyeball is often disproportionately long The optic-nerve connections are not yet fully developed to the cerebral cortex, and their myelination is only beginning The movements of the eyeball at this time are involuntary reflexes and are poorly regulated, although there may be some visual discrimination due to the connections of the retina with the optic thalamus

By two months after birth the structure has so far developed that accommodation of the eye can take place, and at that time the eye is adjustable to distance These advances make it possible for the infant to follow more distant objects with the eyes, thus adding to kinesthesis visual regulation of such reflex movements as have been established earlier

The motor and visual apparatus is now well on the way toward developing those finer spatial discriminations which later find expression in inflectional forms, adverbial and adjectival phrases, adjectives and adverbs Nerve tracts from the retina to all parts of the visual system are present, and the pattern of distribution of the rods and cones in the retina is now reproduced in the optic colliculi, the thalamus, and the visual region in the cerebral cortex However, the myelination of these nerve tracts is by no means complete, especially between the thalamus and the cortex and between the colliculi and the muscular system of the body We cannot therefore be certain that the distribution of the parts of the image over the retinal field is faithfully reproduced in the visual area in such form as to permit a clear perception of the spatial relations of objects in a plane perpendicular to the line of sight Furthermore, connections between the visual and other areas of the cerebral cortex are only partly established, and very little myelination is present in the cortex. We may therefore assume that voluntary control over movement is far from complete, even if present at all

There is excellent reason to suppose that the spatial concepts corresponding to horizontal movements of the eyeballs are among the first, if not the very first, to develop Among the terrestrial mammals the chief objects of interest, those involving the preservation of the species, lie mostly on a level with the eyes, at the right, left, or in front The discrimination of up and down follows soon after that of right and left The visual means of discrimination is supplemented about the fourth and fifth month by the initiation of reaching processes, which add kinesthesis of the arm movements to that of the eyes and postural motion, and make possible the recognition of a local relationship between each hand and the objects lying in its direction

The recognition of distance requires a still further differentiation, involving the convergence of the eyes and an accurate focusing of the lens Much later other factors are added to facilitate this recognition, e g the amount of walking needed to reach an object, the presence of intervening objects, and the complicated processes resulting from the decrease in the size of the retinal image with the increase of distance

The contribution of hearing to localization is of less import, and merely adds to the control over the estimation first of direction and later of distance Hearing comes later than vision

Thus by the fifth month of life the eyes, ears, and muscles of the body, as well as the central nervous system as high at least as the thalamus, have reached a degree of development essential to the ready execution of reflexes corresponding to the concepts of right and left, up and down, and intermediate directions, as well as those of varying distance This is, of course, five or six months before the child will begin to use words, and a much longer time will elapse before he uses spatially significant adjectives and adverbs.

From the structures already present will emerge the modifications and extensions essential to the most minute differentiations of size, shape, direction, and distance with their changes at varying rates of acceleration, as also the higher degrees of mathematical abstraction These must await the slowly maturing structures and integrations of the cerebral cortex, and their coördinations with the simpler processes described above It is interesting to note that these higher ideas transcend the expressive power of oral and written language and can find expression only through elaborate mathematical symbols

Unfortunately anatomists and physiologists have made few

studies of the development of the child's neuromuscular apparatus during the first two years of life, so the possibility of correlating the physical structures and processes with the mental activities is as yet rather limited

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MODES OF CONNECTION IN THE AKLAN DIALECT

FRANK G RYDER

A WORD of extremely frequent occurrence in Aklan texts is *nga* or *-ng* It corresponds to Tagalog *na*, *ng*, and its uses are largely parallel to those of the Tagalog forms It serves the important function of a connective particle or "ligature," as Blake [1] calls it In order to discuss the uses of Aklan *nga* and of the other less frequent connectives we must first classify the forms of the language according to parts of speech But we are faced with the necessity of setting up a very different system from the one employed in the IE languages It is impractical to transfer the conventional terms and classes to Aklan, though most grammars of the IN languages are constructed in that fashion (e g Blake's *Tagálog*) Bloomfield,[2] however, has only two parts of speech for Tagalog — "full words" and "particles." This is certainly the better course, but for the purposes of the present paper it seems wiser to use a more extended classification We may divide Aklan words into two groups·

1 Words whose function in the sentence or phrase can be modified or determined They are the "main words" of Aklan and correspond largely with Bloomfield's "full words," though they have a different definition Since we are going to use the expression "word" very often we shall designate these as "heads"

2 Words which cannot be modified, of which there are the following types

(*a*) Words which exist only in immediate association with heads They are the determining words, which set the function of the head in the sentence We may call them "particles" and list them in

[1] Blake, Frank R., *Grammar of the Tagálog Language* American Oriental Series, Vol I New Haven, 1925

[2] Bloomfield, Leonard, *Tagalog Texts with Grammatical Analysis*, University of Illinois Studies in Language and Literature, Vol 3, No 2 Urbana, 1917

two different classes the nominal particles, *ro*, *sa*, *ko*, *si*, *kay*, *ni*, *manga*, *sanka*, and *it*, and the several verbal particles, e g *nag*(*a*), *gin*(*a*), *um*, *in*, *pa*, *ma*, *un*, etc (prefixes, infixes, suffixes), which denote a modification of time or aspect or mode Typical combinations of particle and head are *ro baeay*,[3] *sa baeay* ('house' used as subject or as a "locative" expression), and *gina kaon*, *kinaon* ('eat' in passive construction)

(*b*) Words which only connect heads or head equivalents — the "connectives" An example is *-ng* in *ro haring Fernando*, 'the king Fernando'

(*c*) Words which stand unconnected in the sentence and are not heads or particles There are several of these in Aklan, as in Tagalog Aklan *daywa-daywa*, 'two by two,' and *sumunud*, 'next,' are typical Since their meaning is usually of the sort we call adverbial it is better to refer to them as "adverbs" rather than to use an unfamiliar word.

This classification has the advantage of enabling us to treat the connectives aside from the particles (the connectives also join heads modified by particles, as *sa baeay nga pa agto sa eawod*, 'in the house toward the sea,' *tanang ro gin sugo kana*, 'all that was told him,' etc) and of creating a separate class for the adverbial expressions

It is to be noted that the head is not further classified into noun, verb, and other parts of speech Those who retain the notion of noun and verb as they are used in IE have difficulty with the IN languages, since almost every head may function in verbal or nominal fashion. The result of the attempt to apply such categories is that one must say, for example, that practically all nouns may be used as verbs, or that some numerals are used as verbs This is impractical It will become apparent that there is no noun–verb distinction for a given word out of context But the distinction of verbal use or nominal use is very important

The broader term "connection" is preferred to "attribution" because of the range of the phenomenon in Aklan It does not appear advisable to use "attribution" or one of its substitutes in the sense that Bloomfield does when he speaks of particles acting as "attributes" of "full words" Attribution is also characteristic of full

[3] Words will be cited generally in Aklan orthography. The only peculiarity is *e*, which is used for [γ], as in Aklan texts For the distribution of the Aklan dialect, etc , see my article "Variant [γ] in the Aklan Dialect of Bisayan," *Pap Mich Acad Sci., Arts, and Letters*, 26 573–583 1940

words themselves and is in Bloomfield's system accomplished by particles This places on the same level two relationships which are better separated The particle–head relation is of one kind, the connection of head and head is of another Only the latter is referred to as connection in this paper

Connection occurs in Aklan between heads or equivalents of heads and not in other situations We must therefore analyze the instances in which heads occur in sequence and discover in which of these a "connective" appears regularly in the language We shall treat as heads both those without accompanying particle and those with particle, i e *baeay* or *ro baeay*, etc Appearance of a nominally used head without a particle is, in any event, largely restricted to connective uses The following classes indicate the general types of sequential relation in which heads may stand in Aklan

I Relation of verbally used head and its nominally used head or heads

II Indirect relation of nominal heads to each other through the same verbal head (only in combination with I)

III Serial relation (indirect), of infrequent occurrence

IV. Direct, nonserial relation, always modificatory in some way, this class is very extensive.

We may make the general statement that in classes I, II, and III the phenomenon of connection does not appear, but that in class IV (not I, II, or III) a connective must be used This should account, with a few exceptions and irregularities, for the presence or absence of the connective in any situation

In discussing class I we use the expressions "verbal" and "nominal," though we have said that almost no Aklan word is per se verb or noun. But in a given phrase it is convenient and often necessary to speak of the head which is *used* verbally and the heads *used* as nominal expressions with it By "verbal head" we mean any head used with *nag*(*a*), *gin*(*a*), etc ,[4] and not at the same time with antecedent *ro*, *ko*, etc By "nominal head" we mean any head used with *ro*, *ko*, and the others, or any combination of particle and head so used (or its substitute, the "pronominal" head) Thus *sininghan*, 'told,' is a verbal head in *sininghan ni Pedro ro matuud*, 'Pedro told

[4] This includes also the substitute verbal heads (related to the verbal heads as pronominal forms are to nominal heads), e g *hay*, *may*, 'is,' 'has '

the truth,' but in *ro sininghan ni Pedro*, 'what Pedro said,' it is nominally used, just as is *ro baeay*, 'the house'

In considering class I we divide the simple Aklan sentence into two parts, the verbal head and the correlated nominal heads (with *ro* and *ko* and *sa*, etc) Whenever these come together there is no connective Thus in *nag abut / ro taw*, 'came the man,' no connective appears between the heads because *nag abut* is a verbal head and *ro taw* is related to it as "subject" (see Bloomfield [*op cit.*] for the idea of "case" in IN generally) This is true also of *umabut / ro taw sa baeay*, 'came the man to-the house', *ro ayam / gina taoan / ko taw it tuean*, 'the dog is given by-the man a bone', *tinuman / ro gin sugo kana*, '(he) followed the told him (what was told him)'

By class II we mean the sequence of heads with *ro*, *ko*, *sa*, or the like, related by these particles to the same single verbal head, that is, related to each other not directly but only through the verbal head There are no connectives between any of these heads The maximum of three levels or "cases" is expressed by *ro* *ko* *sa*, *si* *ni* . *kay*, and *sanka* . *it sanka* . *sa sanka* Thus we have *gina baligya ro saging / ko tendero / sa babai*, 'was sold the bananas by-the farmer to-the woman,' and, in a complex nominal head, *ro gin sugo ko ermitanyo kay Juan*, 'what was told by-the hermit to Juan,' etc

By class III we mean any series of heads on the same level They are infrequent, but may be illustrated by these examples *ro ngaean nanda si Pedro / si Diego / si Juan*, 'the names of them (are) Pedro, Diego, Juan', *nag masakit imaw sa kahadlok / sa anang damgo / sa isaeang gabi-i*, 'became sick he from fright from his dream one night'

Class IV, which is the class of connected heads, is very large, and in free translation the connective is rendered in many ways From the very first, however, we must state the fact that the most efficient and simple analysis of phrases of this kind is obtained by speaking only of heads or equivalent units, and not of "clauses" All instances of class IV can be analyzed as simply as the typical expression *ro pispis nga Adarna*, which illustrates the necessity of *nga* or another connective in any sequence of heads involving direct relation of one member to another (nonserial, modificatory) or, more simply, in any sequence of heads not of class I, II, or III The Aklan phrase may be rendered 'the Adarna bird,' 'the bird, Adarna,' 'the bird which is

the Adarna,' 'the bird, namely, the Adarna,' etc. The elements *ro pispis* and *Adarna* cannot stand together because they are not of class I, II, or III, but must be connected by *nga* (or by other connectives in other phrases) This example also illustrates the rule that *ro* and the like are not repeated after *nga*

For the analysis of more complex sentences we make the assumption that any expression containing a verbal head and whatever correlated nominal heads may occur with it is a unit equivalent to a head A "head equivalent" in a given phrase or sentence is a single central verbal head with all the nominal heads related to it Thus *gin sugo kana ko ermitanyo,* 'was told to-him by-the hermit,' is a head equivalent (if, of course, it contains all the related nominal expressions Here there are two, *kana,* 'to him,' and *ko ermitanyo,* 'by the hermit,' but if there were in the sentence a phrase *sa anang damgo,* 'in his dream,' then the form above could not be a head equivalent until the *sa anang damgo* was counted with it)

It is especially easy to regard such expressions as head equivalents since almost all may be used with *ro* or a similar particle, as, for example, *ro gin sugo kana ko ermitanyo,* which is just like *ro baeay,* 'the house' The head equivalent proper is the part after *ro* In discussing connection the whole expression with *ro,* however, will be treated as a unit, as was *ro baeay* above The entire phrase would be, in proper sentence environment, a nominal head equivalent (see below)

The head equivalent may contain a number of connectives within itself, as does *ro gin sugo kay prinsipeng Juan ko ikadaywang ermitanyo,* 'what was told to prince Juan by-the second hermit,' where all that follows *ro* is a head equivalent and the connectives are between member heads

We may now analyze typical Aklan utterances containing *nga* or the other connectives on the basis of the statement Heads or head equivalents in a sequential relation which is not of class I, II, or III must be joined by a connective; or, Direct, modificatory relation between heads or head equivalents is accomplished by a connective

nga

The connective *nga* is by far the most frequent It is the only general connective and the focus of the whole problem of connection The examples given will clarify its general use, and the discussion

of the other connectives will serve to delimit further its function in the Aklan sentence There is no space to analyze the meanings of *nga* connections [5]

The phonetic features of *nga* are simple After consonant final it is *nga* After vowel final it is usually *-ng*, but sometimes *nga* With *n* final either *n* + *nga* becomes *-ng* (*amon* + *nga* = *among*) or *nga* occurs separately Thus with *tanan*, 'all,' we may have *tanang ro gin sugo kana*, 'all that was told him,' or *sa tanan nga kapispisan*, 'to all the birds'

In *ro pispis nga Adarna* the two heads are not in relation I since neither is a verbal head, nor in class II since, if used with a verbal head in a sentence, they would together constitute the "subject" expression (i e there is no *ro* *ko*, *ro* *sa*, etc, relation), and, of course, they are not in class III Hence they must have the connective (The type of relation, appositional attribution, is discussed by Bloomfield [6]) Similarly we have *si haring Fernando*, 'the king Fernando', *ro poting kabayo*, 'the white horse', *mahabang saewae*, 'long trousers', *ro gakatueug nga ayam*, 'the sleeping dog', *gin sugo kana ko ermitanyo nga ga usoy ko Adarna*, 'was told to-him by-the hermit (that) (he) seek the Adarna' In this last example are two head equivalents, one consisting of the verbal head *gin sugo* with its nominal heads *kana* and *ko ermitanyo*, the other consisting of *ga usoy* and *ko Adarna* in the same fashion

But *tinuman ni Juan ro gin sugo kana ko ermitanyo*, 'was followed by Juan the (what was) told to-him by-the hermit,' has no *nga* because the head equivalent *gin sugo kana ko ermitanyo* is here used with *ro* as "subject" of *tinuman ni Juan* Hence it stands in relation I The whole phrase as given may thus also become a head equivalent connected by *nga*, as in the following *nag basa imaw nga tinuman ni Juan ro gin sugo kana ko ermitanyo*, 'read he (that) was followed by Juan the (what was) told to-him by-the hermit'

Further examples of constructions with *nga* may be cited *umabot imaw sa sanka kahoy nga diamante*, 'came he to a tree of diamonds', *ro matuud nga sininghan ni Pedro*, 'the truth which was-told by Pedro', *ro matuud nga na matay si Pedro*, 'the truth that Pedro died', *nag basa imaw kay Maria nga na matay si Pedro*, 'read he to Maria that Pedro died' Sample sentences in narration are *sinuerte*

[5] For such an analysis see Bloomfield, *op cit*, pp 162 ff

[6] *Loc cit*

si Juan nga sa anang panawan may ermitanyo nga nakakita kana, 'was-fortunate Juan that in his wandering there-was (a) hermit who saw him'; *may manga taw nga nag singhan nga sa bilug nga kalibutan ro maka bueong eang kana hay ro pispis nga Adarna,* 'there-were men who said that in (the) whole world the only thing to cure him (the could cure only him) was the bird Adarna'

A few special uses of *nga* deserve mention The first occurs in the pronominal group typified by *ana* (third singular), which functions as a head, not as a nominal head used with a verb, as do *imaw, kana,* and *na* (all third personal singular, approximately subject, dative object, and agent, respectively) The forms are *akon, imo, ana* for the three persons of the singular, *aton* and *amon* (inclusive and exclusive), *inyo, anda* for the plural They are regularly possessive, as in *ro anang masakit,* 'his sickness,' *ro akong gora,* 'my cap,' *sa anang kagaoy,* 'in his weariness,' but always occur with *nga* This is true as well when they appear with verbal heads *si amo ag si bao nagsaeag it sangpunu nga saging sa suba ag andang inotud,* 'the monkey and the turtle found a stock of banana in-the river and they divided (it)', *anang gin tudan si Juan ko dapat nang himuon,* 'by-him was taught Juan the proper by-him thing-to-be-done (he taught Juan the proper thing for him to do)' In such usage these forms always precede the verbal heads and must be connected by *nga* They are the only members of the pronominal group which regularly precede the verbal head

A further special use of *nga* in Aklan occurs in an expression of the sort which corresponds to our predicate noun For example, 'he turned to, became, stone' is rendered *na himu imaw nga bato* The *bato* is not felt to be in direct relation to the verbal head in the sense of a *sa* or *ko* relation and must therefore have *nga*

Occasionally *nga* is optional Most such uses involve, however, a difference in the interpretation of the part of speech to which one of the connected heads belongs Sentences of the type 'you read well' are rendered by *mayad ka mag basa* or *mayad kang mag basa,* etc In the first translation the *mayad,* 'good,' 'well,' is best interpreted as an adverb; hence there is no connective between it and the rest of the phrase (head equivalent), and the sense is, 'well you read' In the *nga* type the *mayad* is best regarded as a head with the *ka* related to it, either as a regular pronominal form ('you are good that [you] read') or as an enclitic pronoun See *mayad nga*

kumaon, 'good to eat,' *mayad nga pumanaw*, 'good to go' For a further example of optional *nga* see the discussion of *ka*

There are some clear instances in the texts which I used of an apposition rendered without connective *pinatawag ni haring Fernando ro anang kamagueangang onga si prinsipeng Pedro*, 'was summoned by King Fernando (the) his eldest son, (the) prince Pedro' The second member of the apposition contains a regular appositive construction with *nga* The absence of *nga* is fairly common but by no means absolute In the phrase above *nga* may occur The connective usually appears in such situations in Tagalog See, also, *ro parayaw nga prinsipe si Juan*, 'the favorite prince, (the) Juan'

No *nga* appears where two elements constitute a sentence with no copulative verb, *si Juan ro parayaw ko hari*, 'Juan (is, was) the favorite of the king,' or in interrogatives, *sino ro sa sueud ko baeay?* 'who (is) the one inside of the house?'

ko, ni

The other connectives in common use are *ko*, *ni*, and *it*, identical with the particle forms for nominal heads used with verbs There is seldom any confusion of the two uses As connectives *ko* and *ni* have a specific function, contrasted with the wide range of *nga*. They are used instead of *nga* when direct partitive or possessive relation is indicated *ro ama ko akong ama*, 'the father of my father'; *ro silak ko adlaw*, 'the rays of the sun'; *ro parayaw ko hari*, 'the favorite of the king'; *ro tiyo ni Juan*, 'the uncle of Juan'; *sa puno ko kahoy*, 'at the foot of the tree', *ro katamis ko anang huni*, 'the sweetness of its singing', *ro manga kalisdanan ni Pedro*, 'the sufferings of Pedro'

Whenever there is a choice between *nga* and *ko* (rarely *ni*, which is personal) the difference is usually clear The *ko* indicates 'part of', the *nga*, an equational or 'whole' relation. *ro matuud nga sininghan ni Pedro*, 'the truth Pedro spoke,' 'the true thing which Pedro said'; *ro matuud ko sininghan ni Pedro*, 'the truth of what Pedro said,' i e 'true part of' See also *ro kamatuuran ko hinimu ni Pedro*, 'the truth about the action of Pedro'

it

The connective *it* has a rather special function, though it is often interchangeable with *ko*. The special nature of *it* lies in showing that one thing is a part of or is possessed by another in a charac-

teristic or generic relation, thus *ro gatas it anwang*, 'milk of buffalo,' 'buffalo milk', *ro sabaw it niyog*, 'milk of coconut,' 'coconut milk', *ro dueaw it itlog*, 'yellow of egg', *ro gatas it baka*, 'milk of cow,' 'cow's milk' Compare with this last example *ro gatas ko baka*, 'milk of the (particular) cow,' *ro gatas ko anang baka*, 'milk of his cow.' See also *ro silak it adlaw*, 'sunlight,' 'sun's rays,' and *ro silak ko adlaw*, 'rays of the sun', *ro hayag it buean*, 'moonlight,' and *ro hayag ko buean*, 'light of the moon'

ka

The particle *ka* is used as a connective only with cardinal numbers[7] There *nga* is optional in the sense that it usually occurs, along with *ka*, with a number ending in a vowel It may appear, however, with consonant-final numbers, when it alternates with *ka* according to meaning, on about the same basis as do *nga* and *ko* (see above) Illustrative uses are *ap-at ka arado*, 'four plows'; *ro daywang ka igmanghud*, 'the two brothers' (*daywa*, 'two'), *may tatlong ka ongang eaeaki*, 'he has (had) three male children' (*tatlo*, 'three')

If a pronoun form intervenes the *-ng* and the *ka* are both used *ro daywa nang ka igmanghud*, 'his two brothers', *ro pito nang ka kanta*, 'his seven songs' In these examples the pronoun *nang* is postclitic, as in *sa bilug nang ginhari-an*, 'in his whole kingdom'

When *nga* and *ka* are interchangeable *ka* always means simple enumeration, whereas *nga* is again equational. *ap-at ka arado*, 'four plows' (emphasis on 'plows'),[8] *ap-at nga arado*, 'four things which are plows' (emphasis on 'four')

In all probability *ka* is a collective particle, here used with enumerated things It functions in the same fashion as a connective, however, especially in the consonant-final numbers used in the sense of *ap-at ka arado*, above Evidence of its collective nature is clear in *sambato kanda tumawag sa tanan nga kapispisan*, 'one of them called to all the birds,' '. . to all bird-dom' Many other instances might be given

An example from context illustrating several types of connection is the idiomatic Aklan sentence· *sa idaeum* ko *bubon ray Juan* nga

[7] In ordinals we have *nga* (or *-ng*). *ro ikapitong kanta*, 'the seventh song' (*pito*, 'seven').

[8] *Limang beses*, 'five times' (*lima*, 'five'), however, is an example of head-head connection in which one head is a numeral.

nakita hay sanka lugar nga *malhway* nga *may daywang* ka *palasyo* nga *inkantado*, 'at-the bottom of-the well Juan's thing[9] which (*nga*) he saw was a place which was (*nga*) wide where (*nga*) were two palaces which were (*nga*) enchanted,' 'At the bottom of the well Juan saw a wide place where there were two enchanted palaces'

A complete survey of all the problems related to connection is impossible here For the general connective *nga* in particular such a survey would involve a discussion of the adverbs of Aklan (which are unconnected by definition), including besides the ordinary ones like *indi*, 'not,' *ita*, 'on the other hand,' *ano* (interrogative), etc, the conjunctive adverbs, which may be used in the position of *nga*, sometimes with approximately the same translation but not quite in the same sense It may indeed seem advisable in distinguishing the parts of speech to include these words in a special class of "conjunctions," especially since a large proportion of them are of Spanish origin and have been used according to their original function This is a problem for the general syntactic analysis of the Aklan dialect

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[9] *Ray Juan* means 'that which pertains to Juan,' 'Juan's one' (of several things) It is not the subject of *nakita* and must therefore be connected to it by *nga* *Ray Juan nga nakita* = *ro nakita ni Juan*, 'the seen by Juan'

MEDICAL SCIENCE

PARADOXICAL BLOOD-CONCENTRATING ACTION OF RECONSTITUTED PLASMA INJECTED INTRAVENOUSLY IN THE TREATMENT OF TRAUMATIC SHOCK

HENRY N HARKINS

THE use of reconstituted dried plasma in the treatment of traumatic shock seems destined to become one of the important surgical contributions of the last few years This method of treatment is of especial importance today because of its peculiar adaptability to wartime conditions Plasma can be obtained from any suitable blood sample, dried to a powder, and transported great distances or preserved for long intervals without fear of deterioration When it is ready for use sterile water can be added as needed, and the reconstituted plasma injected intravenously Because of the extreme importance of this treatment any new facts about it deserve immediate attention Our work has revealed the following unexpected results

If plasma is injected intravenously, one would expect the blood to become diluted When concentrated plasma [1] is injected intravenously, one would suppose that the blood would become even more diluted than it is after the injection of normal plasma. This is because dilution would occur not only from the plasma added but from the resultant osmotic fluid inflow from the tissues These opinions are based purely on speculation, but similar ones are common in the literature.

Our experiments on the effect of intravenous injections of reconstituted dog plasma [2] in normal dogs produced exactly the opposite

[1] In our experiments we reconstituted our plasma up to only one fourth its original volume, so that the mixture was four times concentrated, the constituents of the reconstituted plasma are thus present in four times the concentration usually found in plasma.

[2] Prepared by the method of Hartman (1940) and made so that its constituents are present in four times the concentration usually found in plasma

results. After the injection of concentrated plasma we found an immediate blood concentration lasting for about thirty minutes and not followed by any secondary blood dilution No definite explanation for this paradoxical reaction can be offered at this time. The possibility exists that the concentration arises from splenic contractions Three out of four splenectomized animals so far studied showed a blood dilution after concentrated plasma injections rather than blood concentration In these experiments, as in the case of

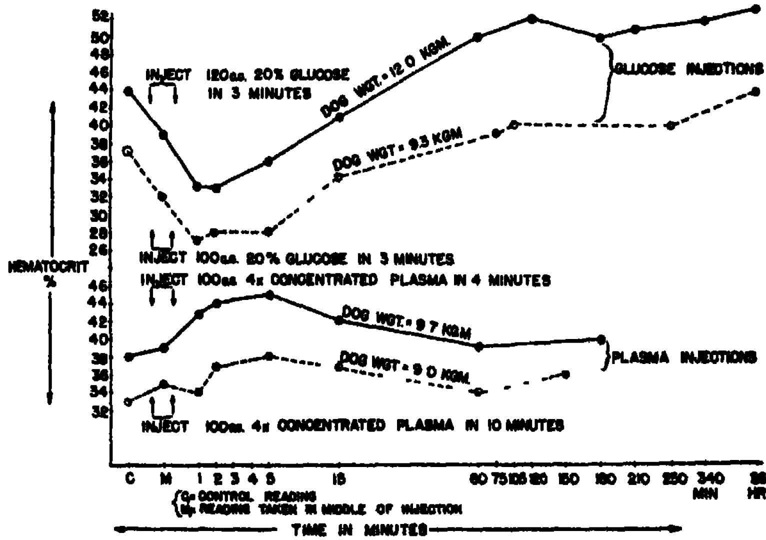

FIG 1 Paradoxical blood concentration following intravenous 4× normal plasma injection The opposite effect in two control dogs similarly injected with 20 per cent glucose solution is shown in the two upper curves, the plasma injections are charted in the two lower curves

the unsplenectomized controls, the plasma administered was reconstituted so that its constituents were present in four times the concentration usually occurring in plasma Experiments in which the animals received 20 per cent glucose injections (i.e four times normal) served as controls The results shown in Figure I were exactly the opposite from those of the plasma injections and revealed a marked immediate dilution, as would be expected.

By assuming the vascular tree of the recipient dogs to be a closed system the following calculations can be made:

A GLUCOSE INJECTION

Dog weight, 12 0 kgm
Calculated blood volume, 920 c c
($\frac{1}{13}$ body weight)
Control hematocrit, 44
Calculated control erythron, 405 c c
Calculated plasma volume, 515 c c
Injection of 120 c c 20 per cent glucose
Final erythron, 405 c c
Final plasma volume, 635 c c
Final calculated hematocrit, 39
Final observed hematocrit, 33

B PLASMA INJECTION

Dog weight, 9 7 kgm
Calculated blood volume, 745 c c
($\frac{1}{13}$ body weight)
Control hematocrit, 38
Calculated control erythron, 285 c c
Calculated control plasma volume, 460 c c
Injection of 100 c c four times normal plasma
Final erythron, 285 c c
Final plasma volume, 560 c c
Final calculated hematocrit, 34
Final observed hematocrit, 45

From these calculations it may be seen that the hematocrit readings after a typical glucose injection indicate that the blood dilution was more than would be expected, with a decrease of eleven points instead of five On the other hand, after a typical plasma injection the blood actually concentrated, the hematocrit increasing seven points instead of the expected decrease of four The excess dilution produced by glucose may be caused by an immediate inflow of tissue fluids into the blood stream, but there is no evidence for such a response to concentrated plasma injections

COMMENT

The fluids used for intravenous replacement therapy of shock include (1) water, (2) crystalloids such as normal saline, Ringer's solution, Locke's solution, glucose, (3) acacia, (4) ascitic fluid, (5) whole blood, (6) red cells, (7) hemoglobin–Ringer solution, and (8) plasma

Of these plasma has many special advantages, particularly in the treatment of shock under wartime conditions, and may be admin-

istered either in its natural state or as reconstituted and dried In the latter form its use has been emphasized by Hartman (1940), Hill and associates (1941), and many others

A search of the literature reveals little that would throw light on the paradoxical blood-concentrating effect of plasma injections observed in our experiments Brennan (1940) noted (1) that as a result of hemorrhage the size of the individual red-blood corpuscles increases very appreciably, often by 30 to 50 per cent or more, and (2) that after hemorrhage very considerable numbers of red-blood corpuscles become sidetracked within the body, probably in the muscle capillaries Often more than 20 per cent of those originally circulating were found to be "missing" in this way Brennan considers that this is due to the inflow into the blood stream of tissue juices of low osmotic pressure which later enter the corpuscles, causing them to swell and clog the capillaries If these corpuscles could be restored to the circulation, the number would correspond to that which would have been given by the transfusion of a liter of whole blood Brennan also shows, in sixteen cases, mainly neurosurgical patients with extensive blood loss, that plasma transfusions will accomplish this return of lost red cells, and they are in reality a type of autotransfusion In these cases plasma from stored blood was diluted half and half with normal saline solution and given rapidly, 500 c c in from 20 to 35 minutes Serial red-cell counts and mean corpuscular volume determinations indicated that after the plasma administration the count increased appreciably, whereas the mean corpuscular volume returned to normal In one case in which a liter of plasma was given over a two-and-one-half hour period the red-cell count increased gradually from 3 2 million to 4 2 million In another case the following changes occurred

	Red-blood cells in millions	*Mean corpuscular volume*
Preoperative	5 5	85 4
Before plasma	3 4	134 8
After plasma	4 6	91 1

This work of Brennan's is of tremendous importance, but unfortunately no controls were presented Not only was the possibility that such changes might have occurred spontaneously not discussed, but no mention is made of the possible rôle of the spleen. Our own

experiments indicate that this organ may be the repository of the red cells that later flood the blood stream

Our work differs from that of Brennan in one other important respect We found a fairly constant ratio between the changes in the hemoglobin and the hematocrit, both before and after plasma administration (see Table I), a condition that shows an absence of marked change in size of the erythrocytes (mean corpuscular volume) This would indicate that in our experiments there was no marked exchange of water between cells and plasma Brennan reported such an exchange

TABLE I

COMPARATIVE HEMOGLOBIN AND HEMATOCRIT ELEVATIONS AFTER CONCENTRATED PLASMA INJECTION

It is seen that the hemoglobin and hematocrit readings agree closely with each other, an indication that there is no marked change in the size of the individual erythrocytes

Injection of 100 c c four times concentrated plasma made in four minutes

Time in minutes after injection	*Hemoglobin gm /100 c c*	*Hematocrit percentage*
Control	12 2	38
1	13 5	43
5	14 5	45
15	13 0	42
60	12 8	39
180	12 3	40

CONCLUSIONS

The intravenous injection of concentrated glucose solution in normal dogs causes blood dilution greater than would be expected if the vascular tree were a closed system The similar injection of concentrated plasma under like circumstances, so far from causing any dilution, effects a paradoxical increase in blood concentration

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HEPARIN IN THE TREATMENT OF THROMBOSIS AND EMBOLISM

CONRAD R LAM

SINCE April, 1939, heparin has been used on thirty selected surgical patients at the Henry Ford Hospital, Detroit, Michigan Several commercial preparations have been tried, and there has been a reasonable opportunity to study their potency and toxicity A number of complications that have arisen in connection with heparin administration will be summarized in this paper Heparin is indicated in any condition in which it is desirable to inhibit the clotting of blood In this series the most common indication was the presence of pulmonary infarction, the material being given to prevent further thrombosis and fatal embolism It is useful in arterial surgery, especially in the removal of emboli from peripheral arteries, in end-to-end arterial suture, and in the grafting of segments of veins

For details of the history and chemistry of heparin, the reader is referred to the review by M F Mason (6) and the monograph by Jorpes (3) It was discovered in 1916 by McLean (5), who was working in Howell's physiology laboratory at The Johns Hopkins University, Baltimore, Maryland The first complete report on it was made by Howell and Holt (2) in 1918 In 1924 E C Mason (7) presented the experience of doctors at the Henry Ford Hospital in the use of heparin in transfusions There were many toxic symptoms, consisting of chills, fever, and headaches After the purification of the material by Charles and Scott (1), Murray (8) of Toronto used it clinically in a large number of patients

The common method of administration of heparin is to give it by continuous intravenous drip Before starting the treatment the clotting time of the patient's blood is determined, and the dosage is so adjusted that the clotting time is kept at about three times the normal value

The choice of the clotting-time method is important In most of the cases in this series the time was determined by the capillary-tube method, in which capillary blood is obtained by finger puncture

By this method the normal time is three to five minutes If venous blood is drawn into the capillary tube, it is six to seven minutes If the test-tube method is used, the time will usually be eight to ten minutes When the time has been elevated to the accepted optimum level by the use of heparin, it should be about fifteen minutes by the first method, twenty by the second, and thirty by the third

Figure 1 shows the effect on the clotting time of two brands of heparin For two days a patient was given Connaught Solution of Heparin, prepared at the University of Toronto The material was administered by continuous intravenous drip as a "2 per cent"

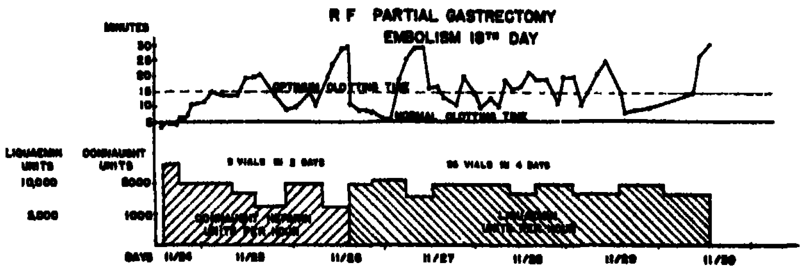

FIG 1. Heparin chart of a patient who was treated with Connaught Heparin and Liquaemin for a period of six days The clotting time was determined by testing capillary blood by the capillary-tube method

solution. This means that 10 c c of heparin (10,000 units) was added to 500 c c. of physiologic saline solution Actually, the concentration of crystalline heparin in such a solution is only 0 02 per cent, because as it is supplied it consists of 100 mg of heparin dissolved in 10 c.c of physiologic saline solution (1 per cent solution) At the end of the second day a different brand of heparin was begun, namely, Liquaemin (Roche-Organon, Inc) Comparable amounts of this material produced the same effect on the clotting time, and there were no chills or other toxic manifestations It will be noted from the chart that 10,000 Liquaemin units were equivalent to 2,000 Connaught units This applies to the Liquaemin brand of heparin marketed in November, 1940, at the present time this brand is placed in a 10-c c. vial, and each vial contains 100 mg. of the crystalline material

Heparin administration is not without complications. Difficulties

may be encountered as a result of the long-continued infusion of saline solution McClure and Lam (4) reported a case with generalized edema from excessive salt intake This trouble has not been encountered since heparin has been given in stronger concentrations, namely, 2 or 4 per cent It is inadvisable to give more than two liters of saline solution per day In patients with cardiac disease even small quantities of intravenous saline may be contraindicated If heparin therapy is imperative, as it would be after embolectomy for peripheral embolism, it may be better to give the material intermittently in the undiluted state Usually, 4 c c is injected intravenously every three hours

Hemorrhage from the operative wound was noted four times Two patients bled from popliteal wounds which had been made during the course of embolectomy One patient had vaginal bleeding after hysterectomy, and one had hemorrhage from the operative wound made by the dissection of an extensive fistula There was one case of concealed hemorrhage in a location remote from the operative area The patient was an obese woman who had had a spinal fusion She was heparinized on account of pulmonary infarctions On the third day of treatment she developed pain in the left thigh, and on the fifth day a swelling was noted, which proved to be a huge hematoma It is probably significant that the blood ascorbic acid in this patient was only 0 20 mg per cent, which indicates latent scurvy

There were four instances of mild phlebitis after the use of a continuous intravenous cannula in the leg Without exception such inflammation disappeared rapidly, but this experience indicates that it is probably preferable to use a vein on the dorsum of the arm or hand, with a needle fastened securely in place

Four patients have died during heparin administration Three of these deaths were certainly unrelated to the treatment, but the fourth was apparently due to massive embolism occurring on the seventh day of heparinization The first patient was a man of 69 years who had arteriosclerotic heart disease, with auricular fibrillation and large infarcts of the lungs from femoral phlebitis At autopsy there was no evidence of fresh infarction The second patient, a man of 59 years, was in terminal heart failure, and expired soon after an unsuccessful attempt to remove an embolus from the iliac artery The third had hemiplegia from occlusion of the internal

carotid artery, and heparin was given for this condition without benefit

The fourth patient had a typical pulmonary embolism on the thirtieth postoperative day after drainage of an appendiceal abscess She was given heparin for one week, at the end of which time she had sudden respiratory distress, began to cough up blood-streaked sputum, and rapidly developed cyanosis, air hunger, and cold skin She expired twenty-four hours after the onset of the attack An autopsy could not be obtained, but clinically this appeared to be a second pulmonary embolism A review of the clotting-time records showed that for several days it had been about ten minutes, but on one occasion it fell as low as six minutes Whether a new clot formed or an embolus broke off a preëxisting clot will never be known

SUMMARY

The experience in the treatment of thirty patients with heparin has been presented, including the complications encountered Two satisfactory preparations of heparin for clinical use are available These are Liquaemin (Roche-Organon, Inc) and Solution of Heparin (Connaught Laboratories, Toronto)

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SOCIOLOGY

CHARLES HORTON COOLEY AND AMERICAN DEMOCRACY

EDWARD C JANDY

HISTORICALLY speaking, every major social movement results in profound changes in the whole structure of a society In such movements we are dealing with collective behavior on a grand scale; hence it is only natural that sociological interests should be involved Yet it must be admitted that not all sociologists are fitted for the task of analyzing these large-scale social trends, either by temperament or training It takes a brooding mind, capable of considerable personal detachment, insight, and broad vision, to sense the *motif*, *élan*, or *Geist* that operated in a society or a whole culture For such a task Charles Horton Cooley [1] was singularly equipped. He had the artist's impatience with details and fragments that did not fit into larger wholes The organic character of his thinking drove him to the pursuit of that which was universal and timeless in the social process In one less competent such a tendency could lead into many an intellectual blind alley, or into the fog of mysticism

Cooley, son of Thomas McIntyre Cooley, who was one of the first professors of the University of Michigan Law School and a justice of the Supreme Court of Michigan, was born on August 17, 1864, in Ann Arbor, Michigan, into a milieu which fostered everything democratic His father was a living symbol of democracy's proud boast that anyone with some natural gifts, drive, and ambition could make good if he seized the opportunities about him The Cooley family life was conducive to "right development" and self-expression in the democratic tradition.[2] The whole community

[1] Charles Horton Cooley (1864–1929) was a pioneer in sociology, author of *Human Nature and the Social Order* (New York Charles Scribner's Sons, 1902, revised 1922), *Social Organization* (New York Charles Scribner's Sons, 1909), *Social Process* (New York· Charles Scribner's Sons, 1918), *Life and the Student* (New York: Alfred A Knopf, 1927), and of some twenty-five articles likewise in the field of sociology

reflected the free atmosphere of Midwestern Jeffersonian democracy. And the University of Michigan, about which this community life mainly revolved, was again symbolic of one of democracy's most vigorous, healthiest institutions — free higher education, with its liberal temper. On its spiritual side, Cooley's democratic faith reflected the breezy freshness of Emerson and Whitman, on its academic side, the scholarly thoroughness of Lord Bryce.

It was in *Social Organization* that Cooley first focused any extended attention upon democracy and the "democratic mind." He saw democracy as a triumphant emergent in the struggle for existence among political and social forms.

> The world is clearly democratizing, it is only a question of how fast the movement can take place, and what, under various conditions, it really involves. Democracy, instead of being a single and definite political type, proves to be merely a principle of breadth in organization, naturally prevalent wherever men have learned to work it, under which life will be at least as various in its forms as it was before.[2]

Unlike a good many of our contemporaries, Cooley never felt that one could pin democracy to a single point of definiteness. He had early concluded for himself, as has been indicated, that it is a way of life, something that can be given a wide scope. Some present-day devotees of democracy are just now awakening to the significance of this. But a number of ideas and ideals are basic to democracy, Cooley strongly believed. Primary groups have as their function, in part, the transmission of fundamental ideals and sentiments to each oncoming generation. These same ideals, having their springs in the playground and the local community, "embracing equal opportunity, fair play, the loyal service of all in the common good, free discussion, and kindness to the weak," underlie both Christianity and democracy. If these modes of life have achieved no notable application to the larger community, it is only because of the magnitude of the task. To put the matter otherwise, Cooley saw Christianity (not the Church) and democracy as protests against all that is formalistic and dead in institutions. "An ideal democracy is in its nature religious, and its true sovereign may be said to be the higher nature, or God, which it aspires to incarnate in human institutions."[3] Perhaps this is one of several instances in which Cooley's particular combination of ethics and religion was a bit

[2] *Social Organization*, p 120 [3] *Ibid.*, p 205

rash. It is understandable, however, when we call to mind that Cooley, like Emerson, was an ardent champion of ethical sovereignty in matters that pertained to human nature and the social order. Both were not so much fighters for democracy as critics of it

It would thus be grossly erroneous to assume that, because at times Cooley's philosophical enthusiasm got in the way of his sounder judgment, he was unmindful of the weaknesses and shortcomings of democracy. He had learned too much from its opponents — Le Bon, Macaulay, Lecky, Sighele, and Sir Thomas Brown — and its more friendly appraisers — De Tocqueville and Lord Bryce — for that Of the commercialism in our culture, its hurry, waste, and strain, he was fully cognizant they are unlovely and uncongenial soil for nurturing higher values, but understandable concomitants of a pioneer age of diffusion, flux, and instability Elemental to Cooley's faith was the idea that human nature is prepared for a higher organization than we have yet worked out; democracy for him was the experimental proving ground for this. "The more men experiment intelligently with life, the more they come to believe in definite causation and the less in trickery Freedom means continuous experiment, a constant testing of the individual and of all kinds of social ideas and arrangements " [4]

Basic to our democratic social organization is our open class system Within it the individual attains his place by means of competition rather than descent Cooley felt that in our country the trends toward the increase or diminution of caste development are mixed Up to now our rapid social change, the high mobility of our population, the swift growth of cities, with their increasingly specialized functions, have all militated against crystallization of classes With continually more stable conditions, in a population comparatively established, the principle of inheritance in property and function will have a greater chance to express itself. To keep classes from becoming closed, democratic forces and ambitious youth will have to assert themselves more and more. Flagrant inequalities must be watched for with vigilance and reduced by social reform, since with them comes a restriction of opportunities. Concerning this, Cooley remarked prophetically·

> Under our flexible modern conditions, it is safe to say, no system can endure that does not make a point of propitiating the formidable ambition of youth by at

[4] *Ibid*, p. 183

least an apparent freedom of opportunity. Even the inheritance of property is constantly questioned in the minds of the young, and nothing but the lack of a plausible alternative prevents its being more seriously assailed And since this stronghold of inequality can hardly be shaken, there is all the more demand that it be offset by opening every other kind of advantage, especially in the way of education and training, to whomsoever may be fit to profit by it [5]

On the matter of class consciousness and the question of its desirability, Cooley was specific and hopeful That there are kindred sentiments, thoughts, and feelings which separate people into classes and even make these classes antagonistic to each other is evident, he felt that such division, in our country, would increase rather than decrease But Cooley's optimism and faith in our democracy were too staunch to lead him to believe a class war possible here His answer is remarkably simple

I see no reason [for it] unless it be a guilty conscience or an unbelief in moral forces A certain sort of agitators expect and desire a violent struggle, because they see privilege defiant and violence seems to them the shortest way to get at it, and on the other hand, there are many in the enjoyment of privilege who feel in their hearts that they deserve nothing better than to have it taken away from them. but these are naive views that ignore the solidity of the present order, which insures that any change must be gradual and make its way by reason [6]

Yet despite this rather facile attitude toward what is now a crucial matter, Cooley admitted the need of some sort of class consciousness it keeps the group concerned from becoming isolated, degraded, ineffective; moreover, it enables it to protect itself from encroachment and neglect by a stronger class Open classes can only remain so if there is not only freedom to rise from class to class, but, more important, freedom to develop according to one's capacities within the class in which one finds oneself. Cooley concludes that "the multitudes who have nothing but their human nature to go upon must evidently stand together or go to the wall" [7]

It is worth noting that there is nothing equivocal about Cooley's treatment of social classes One would go far and wide in the field of sociology to get a better, more balanced, saner view of the matter He recognized that, fundamentally, it is tangible wealth which separates our classes, that the group in whose hands the greatest wealth is grasped also wields the power that goes with it. He despised the mere pursuit of money and respected those who did with-

[5] *Social Organization*, p 233
[6] *Ibid*, p 241.
[7] *Ibid*, p 247

out it, or shunned it to maintain their individuality For him the capitalist class is fittest in the sense that it has energy, tenacity, and shrewdness, these do not make it morally the best Its deficiencies in this respect are due to the impersonality of the commercial world and to the fact that in that world no definite rules of morality can be found

> Since it is hard to say what *is* just and honest in the vast and abstract operations of finance, human nature is apt to cease looking for a standard and to seize booty wherever and however it safely can Hence the truly piratical character of many of our great transactions And in smaller matters also, as in escaping taxation, it is often fatally easy for the rich to steal [8]

The Machiavellian opportunism and the piratical character of a wealthy class, its arbitrary control, all belong to an autocratic rather than to a democratic society There is no mistaking Cooley's view as to how some of this will need to be changed

> In some form or other the democratic principle is sure to make its way into the economic system Cooperation, labor unions, public regulation, public ownership and the informal control of opinion will no doubt all have a part, the general outcome being that the citizen becomes a more vital agent in the life of the whole [9]

Nowhere does Cooley display deeper human sympathy than in his views on the struggles of the lower, ill-paid classes Anyone liberally minded can get much stimulus from his lucid treatment of social problems He deplored the betrayal of the class from which they spring by young men as soon as they become educated and enter fields of larger earnings No less did he deplore the betrayal of the hand-working classes by leaders who are "bought off" with big jobs from the industries whose workers they seek to organize He likewise recognized the dangers in unions dominated by irresponsible leaders Notwithstanding this, Cooley felt that the oppressive action of wealth, of big industries, could only be escaped by organization of the ill-paid classes for their own protection, the trouble with labor unions having been that they "embrace so small a proportion of those that need their benefits." [10]

There is nothing much wrong with our present ideals of democratic

[8] *Ibid*, p 260

[9] *Ibid*, p 264

[10] See, in support of this statement, Cooley, C H., Angell, R C, and Carr, L. J, *Introductory Sociology* (New York: Charles Scribner's Sons, 1933), pp 326–330

freedom in the various categories of American social life The difficulty is that we do not extend them far enough beyond the political sphere into industry and commerce Here alone all the pride and ambition of the individual needs to be enlisted It is just here that democratic and autocratic ideals meet in conflict Strikingly apropos to our present economic situation and our concern about our democratic heritage are Cooley's views Thus in connection with the freedom of each man to rise to a higher social class he remarks

> . it is possible to have freedom to rise and yet have at the same time a miserable and perhaps degraded lower class — degraded because the social system is administered with little regard to its just needs This is more the case with our own industrial system, and with modern society in general, than our own self-satisfaction commonly perceives Our one-sided ideal of freedom, excellent so far as it goes, has somewhat blinded us to the encroachments of slavery on an unguarded flank I mean such things as bad housing, insecurity, excessive and deadening work, child labor and the lack of any education suited to the industrial masses [11]

When one remembers that Cooley held these enlightened views on class relationships more than a quarter of a century ago, one has a healthy respect for him

To classify Cooley as an intellectual liberal is to state an evident fact. He did not go down among the idols of the market place in an iconoclastic mood, with a big stick in hand, but he did criticize the devotees of these idols for the opacity of their social vision and their lack of sympathy with the problems of their less fortunate fellows Some might deprecate his views on the ground that they are value judgments and lack objectivity To these one can almost hear Cooley say, "Assuming that to be true, what do you make of it?" Objectivity can be a mask behind which are hidden the petty fears and class bias of a mind that is liberal only when it costs nothing to pose as such.[12] One is never puzzled as to the real convictions of a liberal like Cooley; he *tells* you what they are.

Cooley saw in socialism "much of what is most vital in the contemporary making of the democratic spirit" And for those who championed unorthodox views he had a healthy tolerance Here is a statement from *Life and the Student*, written in the spirit of Bagehot and Montesquieu

[11] *Social Organization*, p 275

[12] Cooley would doubtless have enjoyed much of Robert Lynd's *Knowledge for What?* (Princeton, N J.. Princeton University Press, 1939).

There are three irrefutable reasons why views that seem dangerous, unpatriotic or otherwise abominable should be freely expressed 1 Discussion is the only way to modify or control them 2 It is the only way to mobilize conservative views in order to combat them intelligently 3 They may be right [13]

The writer cannot restrain the impulse to quote at some length a view Cooley expressed toward the end of his career It synthesizes, in that inimitable style of his, a whole lifetime of sympathetic observation of American life and institutions Here we have a superb description of our American class ethos, for brevity and incisive satire without a peer in social-science literature If Cooley had written nothing more on social classes in our democracy one could have inferred from it alone much of his position on the subject·

The Friday Morning Mail, a splendid magazine, yours for five cents, read by all business men and most college students, having a fabulous income from advertising, is a mirror of our state It has amusing stories, informing articles, illustrations, cartoons, all good of their kind Our civilization is exalted, the capitalist admires himself and his world The rule of business men is assumed to be natural and beneficent, insurgency, if mentioned at all, is discredited in the articles and derided in the cartoons The young are assured that all have an equal chance and that enterprise and virtue will gain them riches and power Poverty is either a myth or a just punishment You would scarcely learn of a strenuous and high-minded labor movement, winning human conditions of living inch by inch in a long struggle against the inertia, greed, and detraction of employers The atmosphere is that of an energetic, good natured, naively exploiting class, by no means hardened or sordid, but superficial and with little sense of social responsibility The American business man is, typically, a good fellow who knows only one sort of idea and has been brought up to believe that virtue is measured by what you can get *A class of such men, possessed of power and driven by emulation, can and do impose their own spirit upon society at the expense of democracy, community, beauty, fulness of life or anything else with which it may conflict* [14]

Cooley in the words just quoted was more prophetic than he knew They were written at a time when the country was at the high tide of prosperity, when, according to some of its rasher prophets, poverty was about to be banished forever But disaster was ahead, economic disaster, not only for the United States, but for the world.

[13] *Life and the Student*, pp 21–22

[14] *Ibid*, pp 44–45 This whole Part I, "Our Time," is perhaps the most fearlessly worded of all Cooley's views Such writing in our universities can only come from men who are themselves "institutions" on our campuses The healthy liberalism expressed by Cooley, his rare insight into what is weak in our democracy, and hence to be excised, and into what is strong and therefore worthy of perpetuity, are a rare treat to the reader who likes clarity and dignity side by side with ripe scholarship

Had Cooley lived a little longer he would have seen the America he loved economically humbled, sharing in a worldwide depression that was to be more disorganizing and demoralizing than but a few dared think. He would have seen unemployment on an unprecedented scale, men disillusioned and in despair, youth wandering in hordes from one end of the country to the other seeking opportunities for work that did not exist He would have seen insurgent farmers resisting at the point of guns those who came to dispossess them and other masses of farmers, whom nature had dispossessed, migrating to the sunnier and more hopeful climes of the West Coast, but rejected everywhere, starved and even beaten But more, Cooley would have seen labor violence in its most virulent form, and the democratic ideals he championed placed in jeopardy In short, he would have seen ushered in a new era of crowd phenomena, a national potpourri of blatant demagogues peddling their socioeconomic nostrums to receptive groups of the disinherited and dispirited, and he would have heard loud appeals and warnings from clergy, politicians, statesmen, and not a few educators In this kind of hysterical *Zeitgeist* the Cooleian type of thinker is at a premium, for the clarity of his mental processes, his patience, and his broad tolerance appear to be indispensable

In the closing of the frontier, in the increased industrialization and the further urbanization coincident with it, and in the cutting off of immigration we have signs of our commercial civilization's achieving maturity Are classes becoming more frozen, so as to impede the free circulation of individuals from level to level? Is there any notable rise of a dependent class? Has there been a closure of opportunities for youth, and does youth tend to follow more the occupational functions of the fathers? Has class consciousness increased and has this tended toward greater economic constraint, tensions, and conflicts? What of that shock absorber between the upper and lower classes — our so-called "middle class"? Are our whole class structure and our democracy at all involved in the profound social movements going on abroad? These are legitimate questions, which Cooley would doubtless raise on the basis of his own views of social classes

Although Cooley never looked for a classless society to develop, he did feel that here "classes will be mainly functioning groups, increasingly open to all through a democratic and selective system of education." This optimism is no longer warranted. There is con-

siderable support for the belief that many of the conditions that made for our open class system no longer obtain This is well portrayed in *Recent Social Trends*

> The occupational shifts of the last decade exhibit the marked characteristics of a maturing industrial and commercial civilization in which freedom of employment opportunity is more limited than in days of vast unclaimed resources and a beckoning frontier There is reason for increasing concern with the revamping of traditional educational and training patterns as a means of enhancing the human values of modern life With the twentieth century has come the beginning of a new quest for stability and security in life in contrast to the easy reliance upon indefinite expansion characteristic of a country in its growth [15]

In *Middletown in Transition* the Lynds show the changes that have taken place with regard to traditional opportunities open to enterprising men "with an idea and a shoe string for capital" [16] These opportunities have gone with the depression Numerous other studies also point to the restriction of jobs for American youth and the curtailment of outlets for ambitious endeavor [17] Sorokin corroborates all this by suggesting that although there has been much occupational shifting — that is, mobility from job to job — little actual change in class status is evident [18]

Cooley once made the interesting statement that one could not find in America a writer of note who would agree that the modern industrial order is making for a permanently factory-dependent class This, too, is no longer true There is fairly general agreement among economists that cyclic breakdowns are indigenous to our economic system, that an ever larger propertyless class, the dispossessed, as well as an increasing army of unemployables are concomitants of technological advance There is little evidence, however, to support Cooley's suspicion of a growing tendency for sons to follow in the occupational footsteps of their fathers Sorokin in his comprehensive work does not find this to be so to any appreciable degree [19]

[15] Ogburn, William F, and others, *Recent Social Trends* (textbook ed, New York and London. McGraw-Hill Co, Inc, 1933), I 269

[16] Lynd, Robert and Helen Merrell, *Middletown in Transition* (New York Harcourt, Brace and Co, 1937), p 69 Further ample support for this belief may be found in Corey, Lewis, *The Crisis of the Middle Class* (New York Covici Friede, Inc, 1935)

[17] The motto of an Eastern graduating class, "W P.A, here we come!" is ironically symptomatic of the closure of opportunities which Cooley feared

[18] Sorokin, Pitirim, *Social Mobility* (New York. Harper and Bros, 1927), Chaps XVII–XVIII

[19] *Ibid*

The occupational shifts of the past fifty years that provide evidence of a decline in the number of independent workers — professional men and officials — and of a constant increase in the dependent classes — industrial wage earners, servants, and lower-salaried workers (the white-collar class) — are nothing short of phenomenal All this has taken place in the transition from an agricultural to an industrial economy [20] There is some suspicion that it is becoming more difficult for young men to enter the professions without the support of other professional men The large number of professional men on the relief rolls of the country is without precedent Whether this indicates a constriction of class lines is a question, that it indicates a swelling of the ranks of a dependent group is not

Further confirmation that our dependent class is growing is best provided by the tragic plight of our farmers For more than fifty years now farm tenancy has been upward, and the equity holdings of our farmers alarmingly downward, since 1920 farm conditions, because of a shrinkage of income and an increase in foreclosure, especially during the depression, have been extremely critical The seriousness of this situation is patent in that traditional methods of relief appear hopeless The rise of a dependent class in America is an ugly though inescapable fact

As to what all this implies in the matter of class consciousness, we cannot be so certain Historically, the free movement up and down the scale of our classes has worked against the development of cohesiveness Common sentiments do not easily develop where much shifting takes place or where there is a persistent feeling and hope that one may rise through ability to a higher rung on the social ladder However intangible and difficult of measurement class consciousness may be, there can be no doubt that it tends to increase when tensions develop or break into open conflict Tensions and conflict are generated in periods of economic crisis and disorganization

The World War forced the class struggle out of sight, but from 1919 to 1921 there was a recrudescence of it Manifestations were again evident in the ugly temper of our insurgent farmers in 1933, when, for the first time in our history, Negro and white sharecroppers in the South organized, despite traditional taboos. Class feeling is

[20] *United States Census Reports*, "Occupational Statistics" (Washington, D. C United States Bureau of Printing, 1930)

undeniably apparent in the epidemic of sit-down strikes in some of our major industries and in the extreme violence of conflict in some of the steel industries Here and there, furthermore, large employer groups have shown an impulse toward total war on organized labor, as evidenced by vigilantism and industrial espionage On the other hand, the meteoric rise in labor unions of common sentiments and interests during the past few years has strengthened labor consciousness and even given labor a sense of unity and power If, lastly, we consider the emotions of the vast army of the unemployed and unemployables supported by government largess and constantly aware of the indignity of their position, we have ample evidence to support the view that however inchoate class sentiment still is, it is on the increase

In discussing the class-struggle theory, Morris Ginsberg makes an observation worthy of note He says

> Class struggle, too, passes through various stages There are periods when the antagonisms of class interests are obscure and class conflicts are either totally concealed or of a minor character Sooner or later, however, when the productive forces of society reach a point where their further development is obstructed by existing social institutions, the class struggle becomes acute and it is then that it becomes the main driving force of social reorganization [21]

Are we at the stage when existing social institutions are so lagging behind the needs of a new era that class struggle becomes acute? There are many able social theorists who frankly believe this to be true, very obviously true on the Continent and in England, perhaps less so in the United States [22]

Harold Laski, regarded as an astute political scientist, surveys contemporary times and presents a realistic though unencouraging picture "The general temper of the world is one of profound and

[21] Ginsberg, Morris, "Class Consciousness," in *Encyclopedia of the Social Sciences* (New York The Macmillan Co , 1930), Vol III

[22] Among the writers who hold more or less to what Cooley would call "the total cleavage theory of social classes" are the following Laski, Harold, *Democracy in Crisis* (Chapel Hill, N C University of North Carolina Press, 1933), *The State in Theory and Practice* (New York Viking Press, 1935), *Where Do We Go from Here?* (New York Viking Press, 1940); Strachey, John, *The Coming Struggle for Power* (New York Covici Friede, Inc , 1933); Corey, *op cit* , and *The Decline of American Capitalism* (New York Covici Friede, Inc , 1934); Palm, Franklin C , *The Middle Classes, Then and Now* (New York The Macmillan Co , 1936); Davis, Jerome, *Contemporary Social Movements* (New York The Century Co., 1930). These books, with the exception, perhaps, of Davis's, have received considerable notice from social scientists in the United States

widespread disillusionment. Our generation seems to have lost its scheme of values Certainty has been replaced by cynicism; hope has given room to despair." [23] He shows how this spirit is reflected in art, literature, and music, and continues.

> The institutions which, a generation ago, were hardly challenged — the public schools in England, the right of American business men to shape the ethos of their civilisation — are now being criticised with an angry hostility which assumes that they are permanently on the defensive
>
> Nor is this all The foundations of our civilisation are being subjected to a criticism more thoroughgoing than at any period since Rousseau burst upon an eighteenth century [24]

Laski then takes up some of the sore spots of modern capitalist democracy the perpetual state of insecurity of our working classes, imperialism and nationalism, with their breeding of wars; the substitution of the divine rights of the capitalist class for the old divine rights of kings; the worship of the god of property rights over all others, the decay of representative institutions, such as parliamentarianism in its various manifestations, both in England and America; and the perilous decline in civil liberties

Unlike Cooley, Laski does not believe more opportunity for education will work toward keeping classes open On the contrary, he is of the opinion that more education for the masses will lead to a different sort of awakening and maintains that capitalist democracy is in a crisis because it cannot "bring liberty in just relation with equality," [25] that is, capitalism attempts to preserve existing inequalities, which democratic process, through education, seeks to abolish And because capitalistic democracy tends to be an unequal society, it has within itself the forces of its own deterioration. It is not so much a question of whether democracy will survive as of whether it can maintain its capitalistic framework. Whether Cooley would demur at the last two conclusions is a matter of doubt. On one basic point Cooley and Laski agree — there is nothing in socialism

[23] *Democracy in Crisis*, p 16.

[24] *Ibid*, pp. 16–17.

[25] There is much evidence to support this view For similar expressions see Russell, Bertrand, *Freedom versus Organisation, 1814–1914* (New York· W. W Norton and Co., 1934), "Liberty and Equality"; Rappard, William, *The Crisis of Democracy* (Harris Foundation Lectures) (Chicago: University of Chicago Press [1938]), especially Chap VI, "The Future of Democracy"; Merriam, Charles E, *The New Democracy and the New Despotism* (New York and London. McGraw-Hill Co, Inc, 1939), especially Part II.

antithetical to human nature; on another they are wide apart, for Laski expresses doubt that a peaceful transition from a capitalistic to a socialistic state is possible.[26]

It is quite likely that Cooley would have found Laski too gloomy a prophet, for Cooley had faith that our democracy is sufficiently elastic to allow for broad experiment and that through intelligent leadership and appeal to the masses it can develop the institutions essential to its perpetuity On the other hand, there are those who would accuse Cooley of the same romantic optimism in democracy that characterized such early intellectuals as Emerson and Whitman With him, as with them, it was a religion

Less than two decades after the appearance of Cooley's *Social Organization* some of the general romantic optimism began to be displaced by an out-and-out pessimism This pessimism expressed itself in the poetry of Edwin Markham, Edgar Lee Masters, and even of Carl Sandburg, in the literature of Zona Gale, Booth Tarkington, Winston Churchill, Sinclair Lewis, and John Dos Passos, in the religious writings of men like Harry Emerson Fosdick, and in the historical treatises of such authors as Charles Beard, James H Rogers, and James Truslow Adams In all these writers we have incinerating criticisms of our economic, political, and social institutions The idols of the market place with their middle-class devotees were the special target of attacks The late Professor Vernon L Parrington summarizes the situation well and even adds a startling prophecy:

> Our intellectual history falls into three broad phases Calvinistic pessimism, romantic optimism, and mechanistic pessimism Between the first and the last lies the America of yesterday that shaped the American mind and American institutions, and with the submergence of the native world, we are in the way of repeating here the familiar history of Europe, with its coercive regimentations reproduced on a large scale and in more mechanical fashion Once more a gloomy philosophy stands on the threshold of the American mind Whether it will enter and take possession of the household, no one can predict

---

[26] Historically it is true, of course, that all revolutionary movements are accompanied by changes in the whole social structure and in the class system within it In his later book, *Where Do We Go from Here?*, Laski is not without hope that in England this transition can come about without violence, if, that is, certain conditions can be fulfilled: the workers must recognise their opportunity and the upper classes must become conscious that they will bring about their own downfall if they do not coöperate intelligently for a more equal society This is an important condition, but one Cooley would perhaps approve.

yet . Yet it is not without hope that intelligent America is in revolt, the intellectual is in revolt, the conscience of America is in revolt [27]

Since these portentous words were written, little has occurred to diminish the skepticism, and even the pessimism, they imply Singularly notable is the vast array of literature that, starting in the post-World War years and reaching an ominous crescendo in the past decade, deals with the crisis of democracy [28]

There is a consensus among the most competent students of the contemporary scene that no greater threat to the democratic way of life exists than fascism Few have stated the situation more succinctly than that able and discerning statesman, Dr Eduard Beneš

This spread of totalitarian regimes in Europe determines the whole development of international and European politics The present confusion, insecurity, and anarchy in culture, morals, politics, in society and economics is both its consequence and its expressions All these facts represent the real tragedy of the European nations after the last world war and illustrate in full clarity the whole moral crisis of present-day Europe [29]

Among the many interpretations of fascism is one that sees it as the last attempt of the upper class to hold its lines of power and control Without the support of that class, in this interpretation, no dictator rises to or long remains in power The middle class, always uncertain of its rôle, then looks to mere survival, and, fearing less the ills it might have under fascism than those threatening it under communism, casts its lot with the upper class and the new elite The *status quo* of class relations is now frozen; educational opportunities and economic competition are denied to all but the

[27] *Main Currents in American Thought* (one-volume ed ; New York· Harcourt, Brace and Co , 1926), Book III, Foreword, pp xix-xx Parrington died in 1929, as did Cooley; present trends are testimony to the realistic understanding he had of the American mind and temper

[28] We cite but a few of the abler books Laski, *opera cit* , Rappard, *op cit.* (Professor Rappard calls attention to the extensive post-World War literature dealing variously with the crisis of democracy; see pp 183-185); Counts, George S , *The Prospects of American Democracy* (New York· The John Day Co , 1938); Merriam, *op cit* , Beneš, Eduard, *Democracy Today and Tomorrow* (New York· The Macmillan Co , 1939). This last book, by one of the foremost statesmen of Europe, the former president of that promising but now extinct democracy Czechoslovakia, is especially excellent if for no other reason than that it is written by a statesman who is also a scholarly sociologist Cooley would have been much impressed by it because he would have shared the enthusiasm and abiding realistic faith of Beneš in democracy.

[29] Beneš, *op. cit.*, p 92.

elect; a religion of the State is set up for worship, and order, obedience, and discipline are exacted through strict censorship, propaganda, and the military arm of the State Here we have the antithesis and negation of democracy Even the most optimistic doubt that these extreme opposites — fascism and democracy — can long live side by side in peace in the community of nations

The crisis that confronts us is new only in the sense that the forces that threaten our way of life from without and within are more complex and crushing The most difficult factor is our creaking economic system Essentially, however, the crisis is a continuation of the old struggle for freedom, this time economic as well as political, social, and intellectual It will take something more than lip service to democracy and a mere faith in moral forces to deal with our situation

There are many, of course, who continue to have the abiding faith in democracy that Cooley had Like him, they affirm that our institutions have elasticity enough to meet the demands of a new epoch They believe, moreover, that it is unnecessary to abrogate entirely our property rights and our traditional reliance upon individual initiative But these students recognize that only bold, concerted, and intelligent action can remove the perils that beset democracy [30]

Perhaps in conclusion we may well raise a few pertinent questions, bearing in mind Cooley's suggestion that democracy must dare be experimental Can we deal with our numerous economic, social, and political problems by further planning and experiment in labor and security legislation, by some redefinition of property rights, regulation of prices, and a more equitable distribution of the profits of industry? In order to cope with the revolutionary changes in our economic, social, and scientific life stronger governmental action and greater centralization of authority will be more necessary in the future — can we have the responsible and able leadership such a

[30] There is considerable unanimity of attitude on this point, as seen in such works as these: Bryson, Lyman, *Which Way America?* (New York The Macmillan Co, 1939); Beard, Charles, *America Faces the Future* (New York Houghton Mifflin, 1932), Mumford, Lewis, *Men Must Act* (New York Harcourt, Brace and Co, 1939), Thomas, Norman, *Democracy vs Dictatorship* (New York. The League for Industrial Democracy, Inc., 1937), Lerner, Max, *It Is Later than You Think* (New York: Viking Press, 1938); Ogburn and others, *op cit.*, Vol I, Chap XXXIII; Counts, *op cit*

new orientation demands along with the coöperation of labor and capital for common survival of our democracy? Lastly, if dictatorships are the spawn of economic crises and wars, can our institutions stand the further strain of preparations for, or actual participation in, another war?

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